BANNARI AMMAN INSTITUTE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NAAC with 'A' Grade)
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B.E. (Automobile Engineering)

Revised 2018 Curriculum & Syllabi

(Candidates admitted during Academic Year 2021-2022)

CONTENTS

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

After graduation, the Graduates of Automobile Engineering will be able to

I. To impart knowledge and skill to formulate, analyze and solve engineering problems in automobiles to meet global challenges.

II. To promote lifelong learning through higher education and research in the automobile and allied engineering.

III. To create automobile technocrats with good communication skills, leadership qualities, team spirit and professional ethics to meet the needs of the society.

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and

write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

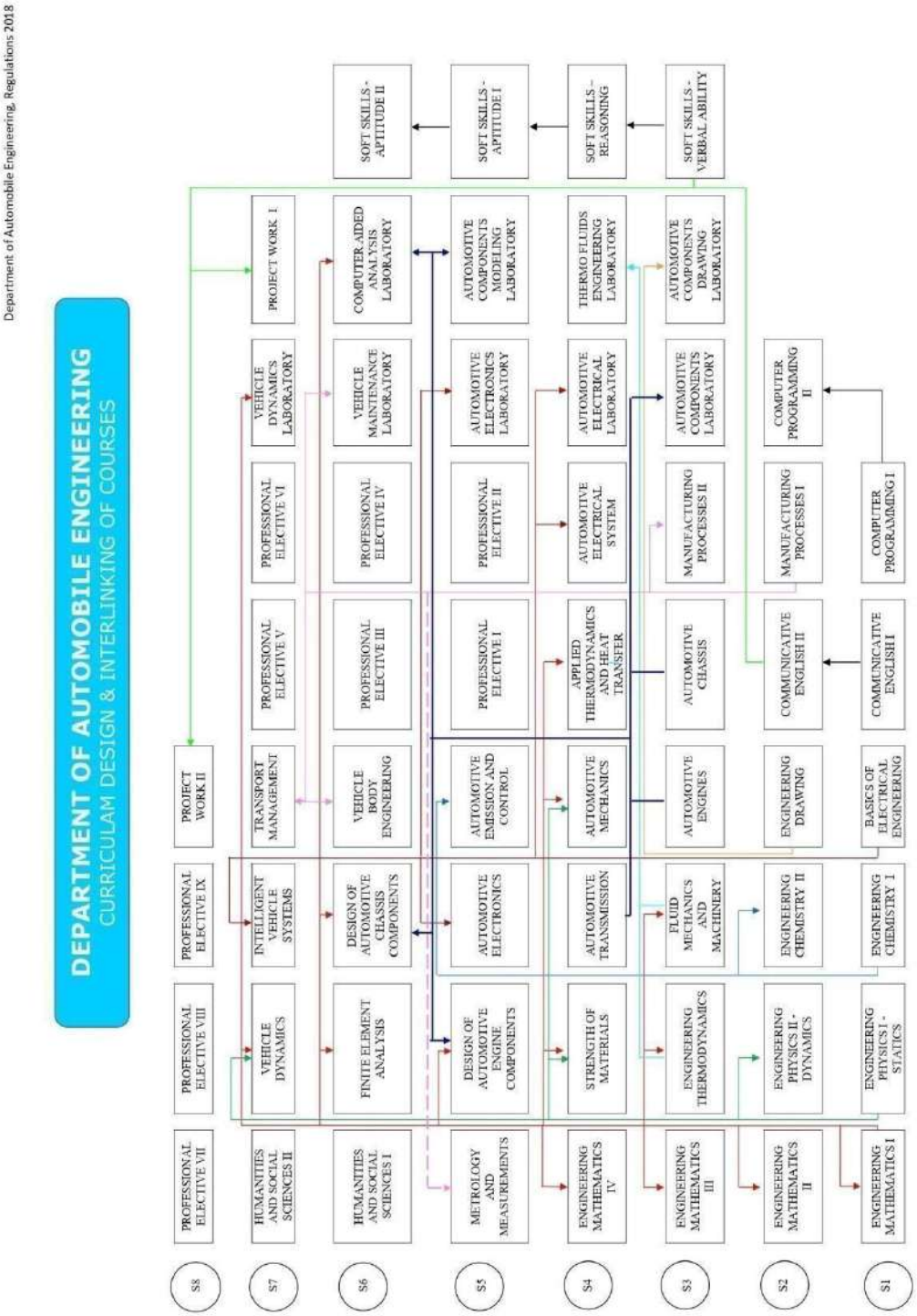
m. An ability to design, analyze and find the solutions for automotive related problems.

n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

MAPPING OF PEOs WITH POs

PEOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
PEO I	X	X	X	X	X								X	
PEO II					X	X	X		X			X	X	
PEO III								X	X	X	X	X		X

CONNECTIVITY CHART



DEPARTMENT OF AUTOMOBILE ENGINEERING
Minimum Credits to be Earned : 161

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18AU101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
18AU102	ENGINEERING PHYSICS I - STATICS	2	0	2	3	4	50	50	100	BS
18AU103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
18AU104	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HSS
18AU106	COMPUTER PROGRAMMING I	0	0	4	2	4	100	0	100	ES
Total		**10**	**1**	**12**	**17**	**23**				-

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18AU201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
18AU202	ENGINEERING PHYSICS II - DYNAMICS	2	1	0	3	3	40	60	100	BS
18AU203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
18AU204	ENGINEERING DRAWING	0	0	4	2	4	50	50	100	ES
	LANGUAGE ELECTIVE	1	0	2	2	3	100	0	100	HSS
18AU206	MANUFACTURING PROCESSES I	3	0	2	4	5	50	50	100	ES
18AU207	COMPUTER PROGRAMMING II	0	0	4	2	4	100	0	100	ES
Total		**11**	**2**	**14**	**20**	**27**				-

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18AU301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	BS
18AU302	ENGINEERING THERMODYNAMICS	3	1	0	4	3	40	60	100	ES
18AU303	FLUID MECHANICS AND MACHINERY	3	1	0	4	4	40	60	100	ES
18AU304	AUTOMOTIVE ENGINES	3	0	0	3	3	40	60	100	ES
18AU305	AUTOMOTIVE CHASSIS	3	0	0	3	3	40	60	100	ES
18AU306	MANUFACTURING PROCESSES II	3	0	2	4	5	50	50	100	ES
18AU307	AUTOMOTIVE COMPONENTS LABORATORY	0	0	2	1	2	100	0	100	ES
18AU308	AUTOMOTIVE COMPONENTS DRAWING LABORATORY	0	0	2	1	2	100	0	100	ES
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	0	2	100	0	100	EEC
Total		**18**	**3**	**8**	**24**	**28**				**-**
IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18AU401	ENGINEERING MATHEMATICS IV	3	1	0	4	4	40	60	100	PC
18AU402	STRENGTH OF MATERIALS	2	1	2	4	5	50	50	100	PC
18AU403	AUTOMOTIVE TRANSMISSION	3	0	0	3	3	40	60	100	PC
18AU404	AUTOMOTIVE MECHANICS	2	1	2	4	5	50	50	100	PC
18AU405	APPLIED THERMODYNAMICS AND HEAT TRANSFER	3	1	0	4	4	40	60	100	PC
18AU406	AUTOMOTIVE ELECTRICAL SYSTEM	3	0	0	3	3	40	60	100	PC
18AU407	AUTOMOTIVE ELCTRICAL LABORATORY	0	0	2	1	2	100	0	100	PC
18AU408	THERMO FLUIDS ENGINEERING LABORATORY	0	0	2	1	2	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	0	2	100	0	100	HSS
18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	0	2	100	0	100	EEC
Total		**18**	**4**	**10**	**24**	**32**				**-**

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21AU501	METROLOGY AND MEASUREMENTS	3	0	2	4	5	50	50	100	PC
21AU502	DESIGN OF AUTOMOTIVE ENGINE COMPONENTS	3	1	0	4	4	40	60	100	PC
21AU503	AUTOMOTIVE ELECTRONICS	3	0	0	3	3	40	60	100	PC
21AU504	AUTOMOTIVE EMISSION AND CONTROL	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
21AU507	AUTOMOTIVE ELECTRONICS LABORATORY	0	0	2	1	2	100	0	100	PC
21AU508	AUTOMOTIVE COMPONENTS MODELING LABORATORY	0	0	2	1	2	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	0	2	100	0	100	EEC
Total		**18**	**1**	**10**	**23**	**29**				**-**
VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HS
21AU602	DESIGN OF AUTOMOTIVE CHASSIS COMPONENTS	3	1	0	4	4	40	60	100	PC
21AU603	VEHICLE BODY ENGINEERING	3	0	0	3	3	40	60	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
21AU607	VEHICLE MAINTENANCE LABORATORY	0	0	2	1	2	100	0	100	PC
21AU608	COMPUTER AIDED ANALYSIS	0	0	2	1	2	100	0	100	PC
18GE601	SOFT SKILLS-APTITUTE II	0	0	2	0	2	100	0	100	EEC
Total		**17**	**1**	**6**	**20**	**24**				**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21AU701	VEHICLE DYNAMICS	3	1	0	4	4	40	60	100	HSS
21AU702	INTELLIGENT VEHICLE SYSTEMS	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
21AU707	VEHICLE DYNAMICS LABORATORY	0	0	2	1	2	100	0	100	PC
21AU708	PROJECT WORK I	0	0	6	3	6	50	50	100	EEC
Total		**18**	**1**	**10**	**24**	**29**				**-**
VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21AU801	PROJECT WORK II	0	0	18	9	18	50	50	100	EEC
Total		**0**	**0**	**18**	**9**	**18**				**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HS201	COMMUNICANITIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS
PROFESSIONAL ELECTIVES										
VERTICAL I: ELECTRIC VEHICLE SYSTEM DESIGN										
21AU001	ELECTRIC AND HYBRID VEHICLE	3	0	0	3	3	50	50	100	PE
21AU002	MATERIAL TECHNOLOGY FOR EV	3	0	0	3	3	50	50	100	PE
21AU003	EV VEHICLE DESIGN	3	0	0	3	3	50	50	100	PE
21AU004	POWERELECTRONICS AND CONTROL OF ELECTRIC DRIVES	3	0	0	3	3	50	50	100	PE
21AU005	BATTERY MANAGEMENT SYSTEM	3	0	0	3	3	50	50	100	PE
21AU006	AI & IoT FOR EV	3	0	0	3	3	50	50	100	PE
21AU007	SAFETY REGULATIONS AND TESTING OF EV	3	0	0	3	3	50	50	100	PE
21AU008	EV CHARGING AND FUEL CELL TECHNOLOGY	3	0	0	3	3	50	50	100	PE
VERTICAL II: AUTONOMOUS VEHICLES SYSTEM										
21AU009	AUTONOMOUS AND CONNECTED VEHICLES	3	0	0	3	3	50	50	100	PE
21AU010	SENSORS AND ACTUATORS	3	0	0	3	3	50	50	100	PE
21AU011	AUTOMOTIVE EMBEDDED SYSTEMS	3	0	0	3	3	50	50	100	PE
21AU012	AUTOMOTIVE COMMUNICATION PROTOCOLS	3	0	0	3	3	50	50	100	PE
21AU013	VEHICLE CONTROL SYSTEMS	3	0	0	3	3	50	50	100	PE
21AU014	MACHINE LEARNING FOR AUTONOMOUS VEHICLE	3	0	0	3	3	50	50	100	PE

VERTICAL III: COMPUTER AIDED AUTOMOTIVE SYSTEMS										
21AU015	COMPUTER AIDED DESIGN AND MANUFACTURING	3	0	0	3	3	50	50	100	PE
21AU016	COMPUTATIONAL AERO DYNAMICS	3	0	0	3	3	50	50	100	PE
21AU017	FINITE ELEMENT ANALYSIS	3	0	0	3	3	50	50	100	PE
21AU018	COMPUTER INTEGRATED MANUFACTURING IN AUTOMOTIVE SECTOR	3	0	0	3	3	50	50	100	PE
21AU019	CFD AND HEAT TRANSFER	3	0	0	3	3	50	50	100	PE
21AU020	INDUSTRY 4.0	3	0	0	3	3	50	50	100	PE
VERTICAL IV: AUTOMOTIVE RESEARCH AND VALIDATION										
21AU021	ADVANCED AUTOMOTIVE MATERIALS	3	0	0	3	3	50	50	100	PE
21AU022	NOISE, VIBRATION AND HARSHNESS	3	0	0	3	3	50	50	100	PE
21AU023	ROAD VEHICLE AERODYNAMICS	3	0	0	3	3	50	50	100	PE
21AU024	ALTERNATIVE FUELS AND ENERGY SYSTEMS	3	0	0	3	3	50	50	100	PE
21AU025	AUTOMOTIVE INSTRUMENTATION AND TESTING	3	0	0	3	3	50	50	100	PE
21AU026	IC ENGINE PROCESS MODELLING	3	0	0	3	3	50	50	100	PE
VERTICAL V: SPECIAL PURPOSE VEHICLES										
21AU027	AGRICULTURAL VEHICLES	3	0	0	3	3	50	50	100	PE
21AU028	DEFENSE VEHICLES	3	0	0	3	3	50	50	100	PE
21AU029	CONSTRUCTIONS VEHICLES	3	0	0	3	3	50	50	100	PE
21AU030	MARINE VEHICLES	3	0	0	3	3	50	50	100	PE
21AU031	OFF ROAD VEHICLES	3	0	0	3	3	50	50	100	PE
21AU032	DRONE TECHNOLOGIES	3	0	0	3	3	50	50	100	PE

Approved in XVIII Academic Council Meeting held on 28.12.2018

VERTICAL VI: PRODUCT AND PROCESS DEVELOPMENT										
21AU033	AUTOMOTIVE PRODUCT DESIGN AND DEVELOPMENT	3	0	0	3	3	50	50	100	PE
21AU034	ERGONOMICS IN AUTOMOTIVE DESIGN	3	0	0	3	3	50	50	100	PE
21AU035	ADDITIVE MANUFACTURING	3	0	0	3	3	50	50	100	PE
21AU036	NEW PRODUCT DEVELOPMENT PROCESS	3	0	0	3	3	50	50	100	PE
21AU037	AUTOMOTIVE PRODUCT LIFE AND MANAGEMENT	3	0	0	3	3	50	50	100	PE
21AU038	AUTOMOTIVE STYLING	3	0	0	3	3	50	50	100	PE
VERTICAL VII: LOGISTICS AND SUPPLY CHAIN MANAGEMENT										
21AU039	AUTOMATION IN MANUFACTURING	3	0	0	3	3	50	50	100	PE
21AU040	MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE	3	0	0	3	3	50	50	100	PE
21AU041	ROBOTICS	3	0	0	3	3	50	50	100	PE
21AU042	LOGISTICS IN MANUFACTURING, SUPPLY CHAIN AND DISTRIBUTION	3	0	0	3	3	50	50	100	PE
21AU043	INDUSTRIAL ENGINEERING	3	0	0	3	3	50	50	100	PE
21AU044	LEAN MANUFACTURING	3	0	0	3	3	50	50	100	PE

ONE CREDIT COURSES										
18AU0XA	PLASTICS – DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING	0	0	0	1		100	0	100	EEC
18AU0XB	VEHICLE TESTING AND CERTIFICATION	0	0	0	1		100	0	100	EEC
18AU0XC	AUTOMOTIVE EMBEDDED SYSTEM	0	0	0	1		100	0	100	EEC
18AU0XD	GASOLINE INJECTION SYSTEMS	0	0	0	1		100	0	100	EEC
18AU0XE	ADVANCED MOTOR SPORTS ENGINEERING	0	0	0	1		100	0	100	EEC
18AU0XF	AUTOMOTIVE PRODUCT DEVELOPMENT	0	0	0	1		100	0	100	EEC
18AU0XG	AUTOMOTIVE INTERIOR COMPONENTS DESIGN	0	0	0	1		100	0	100	EEC
18AU0XH	CONNECTED VECHILES	0	0	0	1		100	0	100	EEC
18AU0XI	MODEL BASED SYSTEM DESIGN	0	0	0	1		100	0	100	EEC
18AU0XJ	VEHICLE DYNAMICS FOR EV	0	0	0	1		100	0	100	EEC
18AU0XK	ELECTRONIC SYSTEM THERMAL MANAGEMENT	0	0	0	1		100	0	100	EEC
18AU0XL	DESIGN AND SELECTION OF HVAC SYSTEM	0	0	0	1		100	0	100	EEC
18AU0XM	ADVANCED NAVIGATION ASSISTANCE THROUGH AUTOMOTIVE IOT	0	0	0	1		100	0	100	EEC
ADDITIONAL ONE CREDIT COURSES										
18GE0XA	ETYMOLOGY	1	0	0	1		100	0	100	EEC
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	1		100	0	100	EEC
18GE0XC	NEURO BEHAVIORAL SCIENCE	1	0	0	1		100	0	100	EEC
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	1		100	0	100	EEC
18GE0XE	YOGA FOR HUMAN EXCELLENCE	1	0	0	1		100	0	100	EEC
18GE0XF	VEDIC MATHEMATICS	1	0	0	1		100	0	100	EEC
18GE0XG	HEALTH AND FITNESS	1	0	0	1		100	0	100	EEC

18GE0XH	CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING	1	0	0	1		100	0	100	EEC
18GE0XI	BLOG WRITING	1	0	0	1		100	0	100	EEC
18GE0XK	COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	1	0	0	1		100	0	100	EEC
18GE0XL	NATIONAL CADET CORPS	1	0	0	1		100	0	100	EEC
18GE0XM	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1		100	0	100	EEC
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1		100	0	100	EEC
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1		100	0	100	EEC

MINOR DEGREE:

VERTICAL I: ELECTRIC VEHICLE SYSTEM DESIGN										
21AUM01	ELECTRIC AND HYBRID VEHICLE	3	0	0	3	3	50	50	100	PE
21AUM02	MATERIAL TECHNOLOGY FOR EV	3	0	0	3	3	50	50	100	PE
21AUM03	EV VEHICLE DESIGN	3	0	0	3	3	50	50	100	PE
21AUM04	POWERELECTRONICS AND CONTROL OF ELECTRIC DRIVES	3	0	0	3	3	50	50	100	PE
21AUM05	BATTERY MANAGEMENT SYSTEM	3	0	0	3	3	50	50	100	PE
21AUM06	AI & IoT FOR EV	3	0	0	3	3	50	50	100	PE

HONOURS DEGREE:

VERTICAL I: ELECTRIC VEHICLE SYSTEM DESIGN										
21AUH01	ELECTRIC AND HYBRID VEHICLE	3	0	0	3	3	50	50	100	PE
21AUH02	MATERIAL TECHNOLOGY FOR EV	3	0	0	3	3	50	50	100	PE
21AUH03	EV VEHICLE DESIGN	3	0	0	3	3	50	50	100	PE
21AUH04	POWERELECTRONICS AND CONTROL OF ELECTRIC DRIVES	3	0	0	3	3	50	50	100	PE
21AUH05	BATTERY MANAGEMENT SYSTEM	3	0	0	3	3	50	50	100	PE
21AUH06	AI & IoT FOR EV	3	0	0	3	3	50	50	100	PE

SUMMARY OF CREDIT DISTRIBUTION

S. No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	10	4						24	14.91%	15%	20%
2	ES	5	8	20						33	20.49%	15%	20%
3	HSS	2	2				2	4		10	6.21%	5%	10%
4	PC				24	17	9	5		55	34.16%	30%	40%
5	PE					6	9	12		27	16.77%	10%	15%
6	EEC							3	9	12	7.45%	7%	10%
Total		17	17	20	24	24	23	20	24	9	161	100	-

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and SocialSciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

18AU101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Represent the different forms of coordinate system in complex plane and characteristics of linear systems by Eigen values and Eigenvectors.
2. Analyse various types of functions and their differentiation techniques involved in engineering fields.
3. Implement different methods of integration used in engineering problems.
4. Execute the suitable integration technique to calculate the area and volume of different surfaces.
5. Apply the concept of analytic function to estimate the integral in complex plane.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2												
3	1	2												
4	1	2												
5	1	2												

UNIT I **9 Hours**

COMPLEX NUMBERS, VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices: Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III **9 Hours**

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchys Residue Theorem.

FOR FURTHER READINGS

Applications-Deflection of Beams, Buckling Analysis, Simple Harmonic motion application in Car Shock Absorbers.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley,2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaum s Outline of Theory and Problems of Calculus, 4thedition, McGraw Hill, 1999.

18AU102 ENGINEERING PHYSICS I - STATICS 2 0 2 3

Course Objectives

- Familiarise basic concepts and force systems in a real world environment
- Provide knowledge on statics of particles in space with moment
- Impart knowledge on equilibrium of rigid bodies.
- Study the moment of surfaces and solids.
- Learn the concepts of static friction.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

Course Outcomes (COs)

1. Draw a free body diagrams for given real world systems to compose and resolve forces involved.
2. Compute the moment created by the applied forces with reference to any centre/axis in 2D & 3D space
   .
3. Estimate the appropriate support system for the given force system by considering the force generated by various reactions.
4. Identify the location of the centroid, centre of gravity for a geometrical body and calculate the moment of inertia for 2D sections.
5. Compute the effect and resultant forces generated by the frictional forces involved in given systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2							2					
2	3	2							2					
3	3	2							2					
4	3	2							2					
5	3	2							2					

UNIT I **5 Hours**

BASIC CONCEPTS AND FORCE SYSTEM

Introduction to mechanics - idealization of mechanics - laws of mechanics - principle of transmissibility- vector - addition, subtraction and product. Force- types - system of forces - resultant forces - composition of forces - resolution of force- free body diagram real world systems

UNIT II **6 Hours**

STATICS OF PARTICLES AND FORCE SYSTEM

Equilibrium of particles, moment of force, moment of couple - equilibrant moment about point and specific axis - simplification of force and couple systems.

UNIT III **7 Hours**

STATICS OF RIGID BODIES

Equilibrium of rigid bodies in two and three dimensions. Trusses - method of joints and method of sections beams - types of loads, supports and their reactions. Two and three force members- static determinacy

UNIT IV **6 Hours**

PROPERTIES OF SURFACES AND SOLIDS

Centroid - Determination of area, volume and mass - Pappus and Guldinus theorems - moment of inertia of plane and area - radius of gyration, parallel axis and perpendicular axis theorems. Product of inertia, mass moment of inertia

UNIT V **6 Hours**

FRICTION

Introduction - mechanism and microscopic origin of friction - Types of friction, Laws of friction, friction on horizontal and inclined planes, wedge friction, friction in screw jack, friction in open V belt drive

1 **3 Hours**

EXPERIMENT 1

Experimental verification of parallelogram law.

2 **3 Hours**

EXPERIMENT 2

Experimental verification of Lamis theorem.

3 **3 Hours**

EXPERIMENT 3

Experimental demonstration of principles of moments using bell crank lever apparatus

4 **3 Hours**

EXPERIMENT 4

Experimental study of equilibrium of forces in three concurrent co-planer systems

5 **3 Hours**

EXPERIMENT 5

Experimental analysis of the reaction forces of a simply supported beam and compare with analytical results.

6 **3 Hours**

EXPERIMENT 6
Determination of centroid of laminas

7 **3 Hours**

EXPERIMENT 7
Determination of moment of inertia of plane area

8 **3 Hours**

EXPERIMENT 8
Determination of mass moment of inertia of a disc - torsion pendulum apparatus

9 **3 Hours**

EXPERIMENT 9
Determination of coefficient of friction between two surfaces

10 **3 Hours**

EXPERIMENT 10
Demonstration of tipping and sliding

Total: 60 Hours

Reference(s)

1. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2007
2. N.H.Dubey, Engineering Mechanics- Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2013
3. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2006.
4. R.C. Hibbeller, Engineering Mechanics: Combined Statics & Dynamics, Prentice Hall, 2009.
5. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010
6. S. Rajasekaran and G. Sankara subramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2005.

18AU103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- Explain the terminologies of electrochemistry to indicate the function of batteries and fuelcells with its electrochemical reactions
- Analyze the three types of fuels based on calorific value for selected applications
- Outline the properties and applications of lubricants and adhesives
- Summarise the fundamentals of corrosion, types and its prevention

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Selection of battery for automobile application
2. Select suitable fuel cell for different automobile application
3. Distinguish the properties of fuel based on thecombustion
4. Identify the properties and application of lubricants used inautomobiles
5. Analyze the type of corrosion and control method in Automobiles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	3	2											3	
3	2												3	
4	3	1											2	
5	2	2											2	

UNIT I **6 Hours**

BATTERIES

Introduction - battery terminology: Construction - working and applications of primary battery (Zinc-carbon)- Secondary battery: Lead Acid, nickel metal hydride, lithium ion and lithium polymer battery - Applications and maintenance of batteries in Automobiles

UNIT II **6 Hours**

FUEL CELLS

Principle - construction and applications of hydrogen-oxygen fuel cell, and Proton exchange membrane fuel cell, Direct-methanol fuel cells, Solid oxide fuel cell, Molten carbonate fuel cell

UNIT III **6 Hours**

FUELS AND COMBUSTION

Automotive Fuels - Types and Properties, Distillation process of crude oil. Combustion: Combustion reaction, Air-fuel mixture, Calorific value, Explosive range, Spontaneous ignition temperature, Abnormal combustion.

UNIT IV **6 Hours**

LUBRICANTS

Lubricants for automobiles - Classification, Functions and Properties: Viscosity index, Flash and fire point, Oiliness, Carbon residue, Aniline point, Cloud and pour point. Greases and synthetic lubricants, Grading of automotive lubricants.

UNIT V **6 Hours**

CORROSION

Corrosion - types of corrosions in automobiles - Uniform corrosion, Galvanic corrosion, Pitting corrosion, Crevice corrosion and Deposit corrosion - Root causes - Remedial measures for corrosion - Protective coatings, Paints, Electroplating

FURTHER READING

Cellulose-based battery used for commercial purposes. Economical loss incurred due to corrosion. Automotive Lubricants

1 **4 Hours**

EXPERIMENT 1

Preparation of N/10 oxalic acid and M/10 sodium carbonate solution

2 **6 Hours**

EXPERIMENT 2

Estimation of corrosion percentage by weight loss method

3 **4 Hours**

EXPERIMENT 3

Battery voltage test and hydrometer test (before and after charging)

4 **4 Hours**

EXPERIMENT 4

Determination of flash and fire point for petrol and diesel

5 **4 Hours**

EXPERIMENT 5

Construct a battery (using scrap metal/ other sources) exhibiting valid output and compare it with the existing commercial batteries based on cost and output. (Marks awarded based on battery output)

6 **4 Hours**

EXPERIMENT 6

Determination of cloud and pour point for petrol and diesel

7 **4 Hours**

EXPERIMENT 7

Determination of viscosity by using Redwood viscometer and Sayboltviscometer

Total: 60 Hours

Reference(s)

1. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publisher, New Delhi, (2013).
2. Charles P.Poole Jr, and Frank J Owens, Introduction to Nanotechnology, John Wiley andSons (2006).
3. Jeffery G.H., Bassett J., Mendham J. and Denny R.C., Vogels Text Book of Quantitative Chemical Analysis, Oxford, ELBS, London, 2002.
4. R. Mukhopadhy and S. Datta, Engineering Chemistry, New Age International Pvt. Ltd, New Delhi, (2010).
5. Shoemaker D.P. and C.W. Garland., Experiments in Physical Chemistry, TataMcGraw-Hill Pub. Co., Ltd., London, 2003.
6. Vogels Text book of quantitative chemistry analysis 5th Edittion, Longman scientific and technical, John Wiely and Sons, New York

18AU104 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

- To understand the types of batteries used inautomobiles
- To illustrate the construction and operation of electrical machines
- To understand the basic concepts of electronic control unit
- To develop a electrical wiring diagram between various parts in automobiles.
- To understand the various components used in protection andtesting.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Explain the types of batteries and its testing methods used in automobiles
2. Illustrate the operating principle of various electrical machines and itsbraking methods.
3. Explain the various components used in electronic control unit and its earthing methods
4. Construct a wiring diagram between between various parts in car.
5. Differentiate the different types of protective schemes and testing used inautomobiles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2										2	
2	3	2											2	
3	2	2	2										2	
4	2	1	3										3	
5	2	2	1										2	

UNIT I **6 Hours**

BATTERY

Types of battery, Rating-12V and 24V system, capacity and efficiency of battery, Various testing methods for battery: Water lever, Voltage level, Cable connections, Temperature, Cranking amperage rating, and Insulator test, Charging methods.

UNIT II **7 Hours**

ELECTRICAL MACHINES

Alternator, Voltage and Current regulators, Construction, operating characteristics and speed control of Permanent Magnet motor, BLDC motor, Electric braking: Eddy current braking and regenerative braking

UNIT III **6 Hours**

POWER SUPPLY AND PROTECTION CIRCUIT FOR ECU

Power supply, rating of power supply and power supply back-up system: ECU, sensors, relays, actuators and display systems. Protection: Over current sensing mechanism, Types of fuses and fuse holders in ECU, Neutral safety switch, Earthing and types of earthing in ECU

UNIT IV **5 Hours**

ELECTRICAL WIRINGDIAGRAM

Types of wires, cables, wiring symbols, wiring diagram between alternator, cut outs, battery, starter motor, wiring diagram of battery to different types of lamps, wiring diagram of battery to drive systems, wiring diagram of audio system.

UNIT V **6 Hours**

PROTECTION AND TESTING

Insulation and earth return system, Fuse, Types of fuses in automobiles, Circuit breakers, Relays, Switches. Testing: Alternator drive belt and Starter motor testing.

1 **6 Hours**

EXPERIMENT 1

Develop a wiring diagram for connecting battery with alternator and cut out.

2 **6 Hours**

EXPERIMENT 2

Develop a wiring diagram between battery and head lamps with necessary protection circuits.

3 **6 Hours**

EXPERIMENT 3

Develop a prototype braking methods for 12V DC motor.

4 **6 Hours**

EXPERIMENT 4

Water level, Voltage level and cable connection testing of batteries

5 **6 Hours**

EXPERIMENT 5

Fuse replacement and earthing methods in automobiles.

Total: 60 Hours

Reference(s)

1. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011
2. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall(India) Pvt. Ltd., 2010
3. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 2014.
4. T.Denton, Automotive Electrical and Electronic System, UK: Elsevier Butterworth-Heinemann, 2004.
5. A.P. Young and L. Griffith, Automobile Electrical Equipment, London: ELBS and New Press 1999.

18HS101 COMMUNICATIVE ENGLISH I **1 0 2 2**

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Use appropriate grammar and vocabulary that is expected at the BEC Preliminary examlevel
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature
3. Write formal, routine letters of factual nature, and make notes on routine matters, such as taking/placing orders
4. Follow simple presentations/demonstrations
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1														
2									2					
3														
4										1				
5										2				

UNIT I **9 Hours**

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for

gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III **9 Hours**

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note Completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making. 1.Goodbye party for Miss Pushpa T S - Nissim Ezekiel 2.Our Casuarina Tree - Toru Dutt 3 Palanquin Bearers - Sarojini Naidu 4. The Tyger - William Blake 5. Ode on a Grecian Urn - John Keats

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

18AU106 COMPUTER PROGRAMMING I **0 0 4 2**

Course Objectives

- Understand the basics of C primitives, operators and expressions
- Gain knowledge about the different primitive and user defined data types
- Impart knowledge about the structural programming concepts

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Implement C programs using operators, type conversion and input-output functions
2. Apply decision making and looping statements in writing C programs
3. Develop C programs using the concepts of Arrays and Strings.
4. Design applications using structures in C.
5. Apply the concepts of functions in writing C programs.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3			3									
2	2	3			3									
3	2	3			3									
4	1	3			3									
5	1	3			3									

1 **6 Hours**

EXPERIMENT 1

Implement a C program which include a Fundamental Data types Integer, Float, double and Character.

2 **3 Hours**

EXPERIMENT 2

Implement a C program to perform the Arithmetic Operations using primitive data types.

3 **6 Hours**

EXPERIMENT 3

Implementation of logical, relational, bitwise, increment/decrement and conditional Operators in C.

4 **3 Hours**

EXPERIMENT 4

Implementation of Simple if else Conditional Statement.

5 **3 Hours**

EXPERIMENT 5
Implementation of nested if else Conditional Statement.

6 **3 Hours**

EXPERIMENT 6
Implementation of Switch Case Statement.

7 **3 Hours**

EXPERIMENT 7
Implement a C program using for Looping Statement.

8 **3 Hours**

EXPERIMENT 8
Implement a C program using Do-While Looping Statement.

9 **3 Hours**

EXPERIMENT 9
Implement a C program using While Looping Statement.

10 **3 Hours**

EXPERIMENT 10
Implementation of Jumping Statements

11 **3 Hours**

EXPERIMENT 11
Implementation of One Dimensional Array.

12 **6 Hours**

EXPERIMENT 12
Implementation of Two Dimensional Array.

13 **3 Hours**

EXPERIMENT 13
Implement a C program to perform String Manipulation Functions.

14 **6 Hours**

EXPERIMENT 14
Implement a C program using structures.

15 **6 Hours**

EXPERIMENT 15
Implement a C program which includes four categories of functions and recursive functions.

Total: 60 Hours

18AU201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinarydifferential equation and solve it by appropriate method.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Illustrate the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyse the convergence and divergence of sequences and series by various tests.
4. Construct first order differential equations from real time phenomena and solve it by suitable method.
5. Execute the appropriate method to solve the second order differential equations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	2												
3	2	1												
4	2	1												
5	2	1												

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only- Greens theorem and Gauss Divergence theorem).

UNIT III **9 Hours**

SEQUENCES AND SERIES

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

UNIT IV **9 Hours**

FIRST ORDER DIFFERENTIAL EQUATIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley,2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

18AU202 ENGINEERING PHYSICS II - DYNAMICS 2 1 0 3

Course Objectives

- Impart knowledge in kinematics of particles
- Familiarize the basic concepts of force, mass and acceleration
- Determine the nature of force associated with work andenergy
- Summarize the motion of rigid bodies
- Solve the realistic problems related to rigid bodykinetics

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Determine the solution for the problems related to kinematics ofparticles.
2. Evaluate the relation existing among force, mass and acceleration ofparticles.
3. Calculate forces associated with work, energy, impulse and momentum.
4. Analyze the geometric motion of rigid bodies.
5. Apply the concepts of rigid body kinetics to solve engineeringproblems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1											2	
2	2	1											2	
3	2	1											3	
4	2	1											2	
5	2	1											2	

UNIT I **6 Hours**

KINEMATICS OF PARTICLES

Introduction to dynamics - Rectilinear motion - displacement, velocity and acceleration - Equations of motion - Curvilinear motion - angular displacement, velocity and acceleration, simple relative motion. Types of coordinates system - rectangular, tangential and normal, radial and transverse.

UNIT II **6 Hours**

KINETICS OF PARTICLES I: FORCE, MASS AND ACCELERATION

Introduction to kinetics - Newton's second law of motion - Equations of motion - Problems on rectangular coordinates, normal and tangential components, cylindrical coordinates - Dynamic equilibrium - D'Alembert's principle.

UNIT III **6 Hours**

KINETICS OF PARTICLES II: WORK ENERGY AND IMPULSE MOMENTUM

Principle of work - conservative and non-conservative forces. Principle of energy - potential energy, kinetic energy, conservation of energy. Principles of Impulse and Momentum - principle of conservation of linear momentum.Impact - direct, central, non-central, oblique - coefficient of restitution.

UNIT IV **6 Hours**

KINEMATICS OF RIGID BODIES

Introduction to planar kinematics - Types of motion - Rectilinear and curvilinear Translation motion, Rotational motion about a fixed axis, General plane motion - Absolute and relative velocity - Instantaneous centre of rotation and acceleration.

UNIT V **6 Hours**

KINETICS OF RIGID BODIES

Introduction to 2-D kinetics - Force and Acceleration - General equations of motion. Principle of work and Energy - work done by a couple, spring - principle of conservation of energy. Principle of impulse and momentum - linear momentum.

Total: 45 Hours

Reference(s)

1. Beer, Johnston, Mazurek, Cornwells and Sanghi, Vector Mechanics for Engineers: Statics, Dynamics, 10th Edition, Tata McGraw Hill - Noida, Uttar Pradesh, 2013.
2. N.H. Dubey, Engineering Mechanics - Statics and Dynamics, First Edition, McGraw-Hill Education India Private Ltd., New Delhi, 2012.
3. R.C. Hibbeler, Engineering Mechanics: Dynamics, 13th Edition, Prentice Hall, 2012.
4. J.L. Meriam and L.G. Kraige, Engineering Mechanics: Dynamics, 7th Edition, Wiley India Private Limited, 2013.
5. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, 4th Edition, Pearson India, 2011.

18AU203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Summarize the physical metallurgy of metals through the study of phase diagrams
- Outline the classification, and heat treatment methods of engineering materials
- Indicate the properties and applications of various metals and non-metals used in engineering industries
- Outline the mechanical properties evaluation and testing methods of engineering materials
- Infer the material behavior through structure-property correlation

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyse the phase changes using phasediagrams
2. Compare the properties of engineering metals and alloy steels and select a suitable metal and alloy for various Engineering applications
3. Analyse the micro-structural changes of steels during heat treatment process and compare the properties of microstructures
4. Select the suitable Polymers and engineering materials for engineering applications and compare the properties
5. Outline the various processing of composite materials

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3											1	
2	3	2											2	
3	3	3											1	
4	3	2											2	
5	3	2											1	

UNIT I **6 Hours**

IRON AND STEEL

Iron carbon system: Allotropes of Iron, Micro constituents of Fe-C phase diagram.Types of steel - low, medium and high carbon steel .types of cast iron -grey, white ,malleable and spheroidal cast iron, application in Automobiles.

UNIT II **6 Hours**

ALLOYS

Alloys: Definition, Purpose of making alloys, Effect of alloying elements, Ferrous alloys - nichrome steel, stainless steel, high speed steel, high strength low alloy steel. Non Ferrous alloys: Aluminium alloys-classification, composition, properties and application of 6111 and 6061. Copper alloys - brass and bronze . Properties and applications of bearing materials, typical application in Automobiles.

UNIT III **5 Hours**

HEAT TREATMENT OF STEELS

Purpose of heat treatment- full annealing, stress relief, recrystallization, spheroidizing, hardening, tempering, normalizing, case hardening - carburizing, nitriding, carbontiriding, flame hardening and induction hardening. Harden ability and its testing.

UNIT IV **7 Hours**

INTRODUCTION TO POLYMERS AND ENGINEERING CERAMICS

Polymers- classification of polymers. Types of polymerization: addition, condensation and copolymerization. Properties and applications of thermosetting- epoxy resin, phenol formaldehyde, PMMA and nylon 66. Thermoplastics- polyethylene(PE), polypropylene(PP), polystyrene(PS), polyvinylchloride(PVC), polytetrafluoroethylene(PTFE) and acrylonitrile butadiene styrene (ABS). Ceramics materials-SiC,SiO2, Partially Stabilized Zirconia (PSZ).

UNIT V **6 Hours**

COMPOSITE MATERIALS

Composite material - definition, classification based on matrix and fiber, processing of polymer matrix composite- hand layup- spray layup-pultrusion, filament winding, Resin transfer moulding, sheet moulding, processing of metal matrix composites - Stir casting , Squeeze casting, typical Automotive applications.

SELF STUDY

Phase rule and applications (one component- Water system and two component- Lead-Silver System). Natural polymers, biodegradable polymers, polymer moulding techniques and extraction of metal from ores.

1 **3 Hours**

EXPERIMENT 1

Microstructure analysis of low, medium and high carbon steels

2 **3 Hours**

EXPERIMENT 2

Microstructure analysis of gray, white, malleable and spheroidal cast iron

3 **3 Hours**

EXPERIMENT 3

Estimation of copper content in brass by EDTA method

4 **3 Hours**

EXPERIMENT 4

Microstructure analysis of stainless steel, high speed steel and aluminum alloy

5 **3 Hours**

EXPERIMENT 5

Determination of hardenability using Jominy end quench test

6 **3 Hours**

EXPERIMENT 6
Analysis of hardening of steel in water and oil quenching medium

7 **3 Hours**

EXPERIMENT 7
Analysis of impact strength of PVC, Nylon and ABS plastics

8 **3 Hours**

EXPERIMENT 8
Analysis of tensile properties PVC, Nylon and ABS plastics

9 **3 Hours**

EXPERIMENT 9
Analysis of impact strength of glass fiber reinforce polymer(GFRP)composites

10 **3 Hours**

EXPERIMENT 10
Analysis of tensile strength of glass fiber reinforce polymer (GFRP) composites

Total: 60 Hours

Reference(s)

1. Jeffery G.H., Bassett J., Mendham J. and Denny R.C., Vogel's Text Book of Quantitative Chemical Analysis, Oxford, ELBS, London, 2002.
2. Shoemaker D.P. and C.W. Garland., Experiments in Physical Chemistry, TataMcGraw-Hill Pub. Co., Ltd., London, 2003.
3. Shoba U.S., Sivahari R. and Mayildurai R., Practical Chemistry, Inder Publications, Coimbatore, 2009.
4. Vogel's Text book of quantitative chemistry analysis 5thEdittion, Longman scientific and technical, John Wiely and Sons, New York.
5. C.P.Sharma, Engineering Materials-Properties and Applications of Metals and Alloys, Prentice Hall of India, New Delhi, 2004.
6. G. Murray, C. White and W. Weise, Introduction to Engineering Materials, 2nd Edition, Chemical Rubber Company (CRC) Press, Taylor & Francis Group, Florida, 2007.

18AU204 ENGINEERING DRAWING **0 0 4 2**

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simplesolids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and viceversa.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Understand the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simplesolids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3									2			2	
2	2									3			2	
3	2									2			3	
4	2									3			2	
5	3									2			2	

1 **10 Hours**

EXPERIMENT 1

Definition, standards, drawing tools, drawing sheets, scales, line and its types. Practices on lettering, numbering, dimension of drawings. Construction of conic sections-ellipse, parabola and hyperbola using eccentricity method.

2 **12 Hours**

EXPERIMENT 2

Principles of projection, projection of points in four quadrants, first angle projection of straight lines - perpendicular to one plane, parallel and inclined to both planes.

3 **10 Hours**

EXPERIMENT 3

Projection of simple planes and projection of simple solids, axis parallel, perpendicular and inclined to one plane using change of position method.

4 **12 Hours**

EXPERIMENT 4

Section of solids - simple position with cutting plane parallel, perpendicular and inclined to one plane.Development of surfaces - simple and truncated solids.

5 **16 Hours**

EXPERIMENT 5

Orthographic projections and isometric view of components used in engineering applications.

Total: 60 Hours

Reference(s)

1. K. Venugpoal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2011.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2008.
4. N.D. Bhatt and V.M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.

18AU206 MANUFACTURING PROCESSES I 3 0 2 4

Course Objectives

- To develop understanding of the basic manufacturing concepts and techniques
- To impart knowledge on appropriate parameters to be used for various machiningoperations
- To acquire knowledge and skill on metal joining processes along with various equipment andits defects

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyze the characteristics of casting processes and its defects.
2. Select the suitable metal joining process for automotive applications.
3. Illustrate the construction and working of lathe and drilling machine
4. Analyze the various operation on milling & gear cutting machines
5. Apply suitable finishing process in manufacturing of automotivecomponents

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2										2	
2	3	2	3										2	
3	2	2	2										2	
4	2	2	3										2	
5	3	2	2										2	

UNIT I **9 Hours**

CASTING

Casting process, Patterns-materials and allowances, Moulding tools, Procedure to make sand mould, Core and core making, Special moulding processes- CO2 process, shell moulding, investment casting, die casting, cleaning of castings, inspection methods, casting defects, causes and remedies.

UNIT II **9 Hours**

METAL JOINING PROCESSES

Principle of Gas welding and arc welding - Electrodes, Fluxes and filler materials. Resistance welding - Spot, butt and seam. Gas metal arc welding(GMAW), Tungsten Inert Gas welding(TIG), Plasma arc welding, Thermit welding, Electron beam welding, laser beam welding and Friction welding - Weld defects - Brazing and soldering

UNIT III **9 Hours**

LATHE

Centre Lathe - Construction, specification. Work holding devices - Centres, chucks, carrier with catch plate and face plates. Operations-turning, facing, and drilling. Boring, taper turning, threading and knurling. Drilling - universal drilling machine, specification , types of drills and nomenclature of twist drill, operations- drilling and reaming.

UNIT IV **8 Hours**

MILLING MACHINE AND GEAR CUTTING MACHINES

Milling - Introduction, types-horizontal and vertical, types of milling - up milling and down milling, operations-Face milling, End milling, T slot milling, gear cutting. Nomenclature of plain milling cutter.. Gear cutting- gear shaper and gear hobbing.

UNIT V **10 Hours**

RECIPROCATING AND SURFACE FINISHING MACHINE TOOLS

Shaper and Slotter - specification. Broaching-types. Finishing processes - Grinding - surface and cylindrical, grinding wheel- specification, Fine finishing processes - Honing, lapping, polishing, buffing and super finishing.

1 **2 Hours**

EXPERIMENT 1

To prepare a mould using split pattern in sand casting process

2 **2 Hours**

EXPERIMENT 2

To prepare a mould for gear pattern

3 **2 Hours**

EXPERIMENT 3

Fabrication of simple structural shapes using manual Metal Arc Welding

4 **2 Hours**

EXPERIMENT 4

Fabrication of simple structural shapes using TIG welding

5 **4 Hours**

EXPERIMENT 5

Exercise on Facing, Step Turning, Boring

6 **4 Hours**

EXPERIMENT 6

Exercise on Taper Turing, Knurling, thread cutting

7 **4 Hours**

EXPERIMENT 7

Exercises on end and face milling

8 **4 Hours**

EXPERIMENT 8
Exercise on Spur Gear Cutting in milling machine

9 **4 Hours**

EXPERIMENT 9
Shaping of square slot

10 **2 Hours**

EXPERIMENT 10
Slotting of key and key way

Total: 75 Hours

Reference(s)

1. SeropeKalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education Limited., New Delhi, 2013.
2. P. N. Rao, Manufacturing Technology- Metal Cutting and Machine Tools, Tata McGraw Hill Publishing Company Private Limited., New Delhi, 2013
3. S. K. HajraChoudhury, Elements of Workshop Technology. Vol. I & II, Media Promoters & Publishers Private Limited., Mumbai, 2013.
4. P.C Sharma, Manufacturing Technology - II, S.Chand & Company Limited. New Delhi, 2012
5. J. P. Kaushish, Manufacturing Processes, Prentice Hall India Learning Private Limited., New Delhi, 2013

18AU207 COMPUTER PROGRAMMING II **0 0 4 2**

Course Objectives

- To understand the basics of C++ and Java primitives, operators, and expressions, conditional and looping statements.
- To understand and apply the concepts of classes, inheritance, interfaces and packages.
- To develop programs using Stings and exception handling.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Implement C++ and java programs using data types, operators, arrays, control and looping statements.
2. Apply class, objects, methods and inheritance in C++.
3. Develop java programs using the concepts of its basic primitives, class and methods.
4. Design applications using inheritance, interface and package.
5. Apply the concepts of strings and exception handling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3			3									2
2	2	3			2									3
3	2	2			2									2
4	2	2			2									3
5	2	2			2									2

1 **3 Hours**

EXPERIMENT 1

Working with basic data types and arrays.

2 **3 Hours**

EXPERIMENT 2

Implementation of control statements.

3 **3 Hours**

EXPERIMENT 3

Implementation of looping statements.

4 **3 Hours**

EXPERIMENT 4
Implementation of class and objects.

5 **3 Hours**

EXPERIMENT 5
Working with constructor and destructor.

6 **3 Hours**

EXPERIMENT 6
Implementation of types of Inheritance.

7 **3 Hours**

EXPERIMENT 7
Working with call by value and call by reference.

8 **3 Hours**

EXPERIMENT 8
Implementation of friend function.

9 **3 Hours**

EXPERIMENT 9
Implementation of overloading.

10 **3 Hours**

EXPERIMENT 10
Working with basic data types, static variables and arrays.

11 **6 Hours**

EXPERIMENT 11
Program on Classes and objects.

12 **6 Hours**

EXPERIMENT 12
Working with Methods.

13 **6 Hours**

EXPERIMENT 13
Implementation of Inheritance.

14 **6 Hours**

EXPERIMENT 14
Implementation of Overloading and Overriding.

15 **6 Hours**

EXPERIMENT 15

Implementation of Packages.

Total: 60 Hours

18AU301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Understand the concepts of Fourier series, Transforms and Boundary Conditions, whichwill enable them to model and analyze the physicalphenomena.
- Summarize and apply the mathematical aspects that contribute to the solution of one dimensional wave equation.
- Understand the basic concepts of probability and the distributions with characteristics andalso the mathematical statistics.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Identify the periodicity of a function and formulate the same as a combination of sine andcosine using Fourier series.
2. Apply the Fourier transform, which converts the time function into a sum of sine wavesof different frequencies, each of which represents a frequency component.
3. Formulate a function in frequency domain whenever the function is defined in timedomain.
4. Classify a partial differential equation and able to solve them.
5. Apply the basic probability axioms and concepts of probability distributions in their coreareas.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	2												
3	1	2												
4	2	1												
5	2	1												

UNIT I **10 Hours**

FOURIER SERIES

Dirichlet conditions-General Fourier series-Odd and even functions-Half range cosine and sine series-Root mean square value.

UNIT II **9 Hours**

FOURIER TRANSFORM

Fourier Integral Theorem-Fourier Transform and Inverse Fourier Transform-Sine and Cosine Transforms -Properties- Transforms of Simple Functions-Convolution Theorem-Parsevals Identity.

UNIT III **9 Hours**

PARTIAL DIFFERENTIAL EQUATION

Introduction to partial differential equations- One-dimensional wave equation-Method of separation of variables-D Alemberts solution of the wave equation-Heat equation-Laplace s equation-Telegraph equations-Laplace transform method ofsolution.

UNIT IV **9 Hours**

LAPLACE TRANSFORM

Properties and theorems of Laplace transform-Shifting theorems-Convolution-Applications to ordinary differential equations. Applications to linear system analysis.

UNIT V **8 Hours**

PROBABILITY THEORY

Probability- Random variables- probability densities and distributions-mean and variance of a distribution -Conditional probability-Bayes theorem-Binomial, Poisson and normal distributions.

Total: 60 Hours

Reference(s)

1. KreyszigErwin, Advanced Engineering Mathematics, 10th Edition, John Wiley, 2011.
2. Johnson Richard A. and BhaltacharyyaGouri K., Statistics, Principles and Methods, 7th Edition, John Wiley, 2014.
3. ONeil Peter V., Advanced Engineering Mathematics, 7th Edition, PWS-Kent, 2011.
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 4th Edition, 2011.
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 4th Edition, 2003.
6. https://nptel.ac.in/syllabus/syllabus.php?subjectId=122107037

18AU302 ENGINEERING THERMODYNAMICS 3 1 0 4

Course Objectives

- To acquire knowledge on fundamentals of thermodynamic laws, concepts, principles and mechanism in accounting for the macroscopic physical systems.
- To formulate and solve engineering problems involving classical thermodynamics for closed and open systems.
- To familiarize the students with basic concepts of Second Law of Thermodynamics andentropy
- To grasp knowledge about thermodynamic property of pure substances and its phase change processes.
- To learn about principles of psychrometry and concepts of air standard cycles.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Exemplify the basic concepts and zeroth law of thermodynamics.
2. Apply the first law of thermodynamics to closed and opensystems
3. Apply the second law of thermodynamics for the calculation of entropy and compare heat engine and heat pump.
4. Determine the thermodynamic properties of pure substances and its phase changeprocesses.
5. Analyze the air standard performance of heat engines and properties of gas mixtures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											2	
2	2	3											2	
3	3	2											3	
4	3	2	3	2									3	
5	2	3		3									3	

UNIT I **8 Hours**

INTRODUCTION AND ZEROTH LAW OF THERMODYNAMICS

Definitions and concepts- heat, work, thermodynamic equilibrium, system and types, surroundings, Properties- intensive and extensive properties, Path and point functions, Energy- macroscopic and microscopic modes of energy, Thermodynamic processes and cycle, State postulate, Zeroth law of thermodynamics.

UNIT II **10 Hours**

FIRST LAW OF THERMODYNAMICS

First law of thermodynamics, First law for Closed systems - constant pressure process, constant volume process, constant temperature process, adiabatic process, polytropic process, throttling process. First law for open systems -Steady state flow processes, Steady flow energy equation (SFEE), Application of SFEE-turbines and compressors, nozzles and diffusers, throttling valves, heat exchangers.

UNIT III **8 Hours**

SECOND LAW OF THERMODYNAMICS

Limitations of First law of thermodynamics, Second law of thermodynamics- Kelvin - Planck and Clausius statements, Heat Engine, heat pump and refrigerator, Reversibility and irreversibility-irreversible and reversible processes, Carnot"s principles, Thermodynamic temperature scale, Clausius inequality, Entropy- principle of entropy increase, Availability & irreversibility.

UNIT IV **9 Hours**

PROPERTIES OF PURE SUBSTANCES

Thermodynamic properties of fluids.Pure substance-phases - Phase change processes, Property diagrams - pressure-volume (P-V), pressure-temperature (P-T), temperature-volume (T-V), temperature-entropy (T-s), and enthalpy-entropy (h-s) diagrams.Steam tables - Problems on flow and non-flow processes.Ideal gas - equation of state, Van der Waals equation and compressibility chart.

UNIT V **10 Hours**

GAS MIXTURES AND GAS POWER CYCLES

Thermodynamics of ideal gas mixture- mixture of ideal gas, mixture of perfect gases, Dalton"s law of partial pressure, Amagat"slaw,Thermodynamic properties, Psychrometric properties and processes - Psychrometric chart. Air standard cycles - Otto, Diesel and Dual - Calculation of mean effective pressure and air standard efficiency.

Total: 60 Hours

Reference(s)

1. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGrawHill Publishing Company Pvt Ltd, New Delhi, SiE,7e,2016
2. R.K.Rajput, Engineering Thermodynamics, Laxmi Publications Pvt.Ltd., New Delhi, 2015.
3. R. S. Khurmi, Steam table with Psychometric chart, S. Chand Publications, New Delhi 2009.
4. J. P. Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi 2002.
5. P.K Nag, Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2016.
6. https://nptel.ac.in/courses/101104063/

18AU303 FLUID MECHANICS AND MACHINERY 3 1 0 4

Course Objectives

- To understand the basics of fluid properties and the laws of fluid mechanics.
- To acquire required knowledge to solve internal and externalflows.
- To understand the concept of flow through pipes including major and minor losses.
- To understand the concept of dimensional analysis and modelling techniques.
- To gain knowledge on the working principles and performance analysis fluid machineries.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Solve problems for velocity, flow and force using fundamental laws fluids.
2. Apply internal and external flow mechanisms to design fluid components.
3. Apply the fluid mechanics principles to solve the problems on flow through pipes andpipe networks.
4. Model fluid flow prototype components using models and modelling laws.
5. Analyse turbines and pumps for optimum performance conditions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2											2	
2	3	2	3	1									1	
3	3	2	3	2									3	
4	3	2	3										2	
5	3	2	3	2									2	

UNIT I **8 Hours**

INTRODUCTION TO FLUID AND FLUID MOTION

Fluid- Fluid mechanics -Laws of Fluid Mechanics-Properties of fluid and its application-Types of fluid - Types of fluid flow-Measurement of pressure-U-tube and differential manometer- Measurement of velocity using Discharge -Actual discharge-Flow pattern-law of conservation of Mass, Energy, Momentum -continuity equation. Buoyancy-meta centre, conditions of equilibrium of floating and submerged bodies.

UNIT II **10 Hours**

FLUID DYNAMICS AND FLUID FLOW IN CONDUITS

Forces acting on a fluid element- Euler"s and Bernoulli"s theorem- Application in internal and external flow measuring instruments Ã¢?? Applications of Momentum equation for bend in pipes - Major losses and Minor losses in pipes -Darcy Weisbach equation -pipes in series and pipes in parallel. Identification of laminar and turbulent flow in closed conduits, flow in circular pipe. Fuel and lubricants flow.

UNIT III **10 Hours**

EXTERNAL FLOW OVER BODIES AND DIMENSIONAL ANALYSIS

Fluid flow over Bodies: Boundary layer theory, Flow separation-Boundary layer development on a flat plate -Lift and drag of an aerofoil& Car. Need for dimensional analysis - dimensional analysis using Buckingham pi theorem - Similitude -types of similitude - Dimensionless parameters- application of dimensionless parameters - Model analysis through Reynolds and Froude"s Model law.

UNIT IV **8 Hours**

HYDRAULIC TURBINES

Turbine -Classification -Impulse turbine -Reaction turbine-Francis turbine - working principles and velocity triangle- Work done by water on the runner - Specific speed - unit quantities - performance curves.

UNIT V **9 Hours**

HYDRAULIC PUMPS

Centrifugal pump -Classification -Construction - working principle and velocity Triangle-Head-Losses and efficiencies-Specific speed -Priming and cavitation effects of centrifugal pump. Reciprocating pump - Classification - Working Principle.

Total: 60 Hours

Reference(s)

1. Yunus Cengel and John Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 4th edition, 2017.
2. Frank M. White, Fluid Mechanics (in SI Units), McGraw-Hill Education / Asia, 2011
3. R.K.Bansal, A Text book of Fluid Mechanics and Machinery, Laxmi Publications (P) Ltd., New Delhi, Revised 9th edition, 2018.
4. Victor L. Streeter, K.W. Bedford and Wylie E. Benjamin , Fluid Mechanics, Tata McGraw Hill Publishing Company Pvt Ltd., New York, Revised 9th Edition 2010.
5. Bruce R Munson , Donald F Young, Theodore H Okiishi and Wade W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley & Sons, 8th edition 2016.
6. https://nptel.ac.in/courses/112105171/

18AU304 AUTOMOTIVE ENGINES 3 0 0 3

Course Objectives

- To acquire knowledge on the primary engine components and the subsystems ofautomotive engines
- To understand spark ignition and compression ignition engines fuel systems inautomotives.
- To develop understanding of combustion process in SI and CI engines.
- To develop the requirements of cooling and lubricationsystems.
- To carry out performance test on automotive engines.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Select the suitable engine components and valve operating mechanisms for modernautomobiles.
2. Select the suitable fuel supply system for modern vehicles.
3. Differentiate spark ignition and compression ignition combustion chambers used in automotive engines.
4. Select appropriate cooling system for automobile engines.
5. Compare turbo and supercharging systems and performance characteristics of engines using dynamometers.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3												
2	3	3											2	
3	2	3											3	
4	2	2												
5	2	3											2	

UNIT I **8 Hours**

ENGINE COMPONENTS

Four stroke, Two stroke, SI and CI engines- constructional details and materials of engine components, cylinder, piston assembly, connecting rod, crankshaft, cam shaft, flywheel, cylinder head, valves, Intake and exhaust system components, Valve operating mechanisms, Valve timing and port timing diagrams.

UNIT II **9 Hours**

FUEL SYSTEM

Air-fuel ratio requirements of SI engines, SI engine fuel systems, Carburetors- types, Gasoline fuel injection systems- Multi Point Fuel Injection (MPFI), throttle body injection , Electronic fuel injection- Gasoline Direct Injection System (GDI), CI engine fuel injection systems- unit injector and Common Rail Direct Injection(CRDI) systems, inline plunger injection pump, distributor pump, Injection nozzles-types, Mechanical governor for fuel injection pumps.

UNIT III **10 Hours**

COMBUSTION AND COMBUSTION CHAMBERS

Stages of combustion in SI engines, Factors affecting ignition delay and flame propagation, Abnormal combustion-knocking, control of knock, octane rating of SI engine fuel, Combustion chambers for SI engines, Stages of combustion in CI engines- factors affecting ignition delay, CI engine knock, cetanerating of CI engine fuel, Comparison of SI engine and CI engine knock, Direct and indirect injection combustion chambers for CI engines- importance of swirl, squish and turbulence in CI engines.

UNIT IV **9 Hours**

COOLING AND LUBRICATION SYSTEMS

Need for cooling, Effects of over cooling, Air and liquid cooling systems- thermo siphon, forced circulation and pressure cooling systems, components liquid cooling system, Requirements of coolants-anti freezing agents, Requirements of lubrication system, Types- mist, pressure feed, dry and wet sump systems.

UNIT V **9 Hours**

SUPERCHARGING, TURBO CHARGING AND ENGINE TESTING

Supercharging- need and methods, Turbocharging-Engine exhaust manifold arrangements, Engine performance- indicated, brake and friction power, indicated thermal, brake thermal and volumetric efficiencies, specific fuel consumption, Measurement of engine power- fuel consumption, air flow rate and speed, Engine loading- types of dynamometers , Morse test and heat balance test.

Total: 45 Hours

Reference(s)

1. V. Ganesan , Internal Combustion Engineering, New Delhi :Tata McGraw-Hill PublishingCo, 2012.
2. J.B.Heywood , Internal Combustion Engine Fundamentals, New Delhi :Tata McGraw-Hill Publishing Co, 2011.
3. K.K. Ramalingam , Internal Combustion Engines, Sci-Tech Publications, 2009.
4. Heisler, "Advanced Engine Technology" SAE Publication, 1995.
5. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd. 2013.
6. M.L. Mathur, R.P. Sharma,A course in internal combustion engines, Dhanpatraipublication, 2010.

18AU305 AUTOMOTIVE CHASSIS 3 0 0 3

Course Objectives

- To acquire knowledge on types of chassis frames and drive axles.
- To understand the constructional details of suspension system, brake system and steeringsystem of road vehicles
- To explain the layout and components of vehicles with front, rear and four wheel drive

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Summarize the chassis layout, frames and drive axles of anautomobile.
2. Analyze the mechanisms and geometry of steering system.
3. Differentiate the suspension systems based on their application.
4. Contrast the functions of the drive line components depending on their location.
5. Compare the various braking systems based on their construction and workingprinciples.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2				2									
2	2	3			3	3							3	
3	2	3			3	2							3	
4	2	3			3	2							3	
5	2				3	3								

UNIT I **9 Hours**

CHASSIS FRAMES AND AXLES

Types of chassis layout with reference to power plant location and drive, Frames- types, loads acting on frame and materials, testing of frames, Front Axles and stub axles- types, Drive axles- loads acting on drive axles, Types of drive axles- full floating, three quarter floating and semi floating axles, axle housings and types.

UNIT II **9 Hours**

STEERING SYSTEM

Condition for true rolling motion of wheels during steering- Ackerman"s and Davis steering mechanisms, steering linkages, steering columns, steering gear box, rack and pinion type, recirculating ball type, Power steering- hydraulic and electronic power steering, Steering geometry- castor, camber, steering axis inclination, turning radius and toe, Four wheel steering.

UNIT III **9 Hours**

SUSPENSION SYSTEM

Purpose and components of suspension system, Types of suspension springs, Sprung and unsprung weight, Front suspension system- Macpherson strut, torsion bar, coil spring and leaf spring front suspension, Rear suspension system- leaf spring, coil spring, strut type and torsion bar rear suspension, Shock absorber- purpose, types and operation, pneumatic and hydro , Elastic suspension spring systems, Active suspension system.

UNIT IV **9 Hours**

DRIVE LINE

Effect of Driving Thrust, torque reactions and side thrust, Hotchkiss drive and torque tube drive- radius rods and stabilizers, Propeller shaft- universal joints, constant velocity universal joints, slip joints, Front wheel drive, Final drive- double reduction and twin speed final drives, Differential- function, principle and types, differential housings, limited slip differential, differential locks.

UNIT V **9 Hours**

BRAKING SYSTEM, WHEELS AND TYRES

Need for brake systems, Drum brake and disc brake- construction and working of mechanical braking system, hydraulic braking system and pneumatic braking system, Power-assisted braking system- servo brakes, antilock braking systems, Electronic Stability Program. Wheels - type and construction, Tyres- radial and bias tyres, construction, tyre pressure, effects of over and under inflation, tubeless tyres, tyre specifications, tyre manufacturing.

Total: 45 Hours

Reference(s)

1. P.M. Heldt, Automotive Chassis, New York: Chilton Co, 2014.
2. K. Singh, Automobile Engineering-Volume 1, Delhi: Standard Publishes Distributors, 2012.
3. R.K. Rajput, A Text Book of Automobile Engineering, Delhi: Laxmi Publications Private Limited, 2007.
4. N.K. Giri, Automotive Mechanics, New Delhi: Khanna Publishers, 2005.
5. N.Steeds and Garret, Motor Vehicles, London: Butterworth, 2005.
6. H. Hazler, Modern Vehicle Technology, London: Butterworth, 2005.

18AU306 MANUFACTURING PROCESSES II 3 0 2 4

Course Objectives

- To learn the metal cutting theory, measure the forces acting on the single point tool and calculate various forces involved in it.
- To provide working skill and knowledge on construction and working of special lathes and CNC machines and also gain basic working skills for making simple components in automaticlathe.
- To impart the knowledge on working of metal forming process and provide working skill on sheet metal operations.
- To familiarize about the working of powder metallurgy processes and to provide working skills in non-traditional machining process (EDM).
- To provide knowledge on working of plastic manufacturing methods and to gain basic working skills in injection moulding process.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Explain the metal cutting theory and calculate the various forces acting on the lathe turningtool using Merchant circle.
2. Find out the suitable lathe machine/CNC machine based on the application and produce simple components using these machines.
3. Analyse the metal forming and sheet metal operations for the production of components and make simple components using theseprocesses.
4. Select the suitable powder metallurgy and non-traditional machining process based on the application and produce simple components using grindingmachines.
5. Choose the suitable plastic manufacturing method based on the application and producesimple components using inject moulding process.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3					1		2			1		3
2	2	3							2			1		3
3	2	3							2			1		3
4	2	3							2			1		3
5	2	3							2			1		3

UNIT I **10 Hours**

THEORY OF METAL CUTTING

Introduction to metal cutting method-mechanics of metal Cutting-orthogonal-oblique-Merchant"s circle diagram-details of derivation-chip formation-chip thickness ratio and shear plane-cutting tool nomenclature-tool wear, cutting tool life cutting speed, feed, depth of cut, cutting tool materials and cutting fluids, Recent developments and applications-dry machining, high speed machining.

UNIT II **9 Hours**

SPECIAL LATHES AND CNC MACHINES

Capstan and turret lathes - constructional features, specification, operations-Automats-Single spindle automatic lathe, multiple spindle automatic lathes-constructional features, specification, operations. Numerical Control (NC) machine tools-CNC types, constructional details, special features-coordinate system-Preparatory functions, Axis motion commands, Feed and speed commands, Miscellaneous command.

UNIT III **9 Hours**

METAL FORMING AND SHEET METAL PROCESS

Hot working and cold working of metals-Forging-open die forging, closed die forging-Rolling of metals-types of rolling - Extrusion-hot and cold extrusion-Sheet metal characteristics-shearing, blanking, punching, bending, trimming, perforating and drawing operations-Stretch forming-rubber forming-hydro forming-Thermoforming-Mechanical, vacuum, pressure.

UNIT IV **9 Hours**

POWDER METALLURGY AND NON CONVENTIONAL MACHINING PROCESS

Introduction to Powder Metallurgy process-preparation of powders, types & function of binders, green compaction-sintering process-Introduction to non-traditional machining process-water jet machining(WJM), wire cut EDM-laser beam machining-electron beam machining-electro chemical machining-plasma arc machining.

UNIT V **8 Hours**

FORMING AND SHAPING OF PLASTICS

Types of plastics - Moulding of Thermoplastics-Working principles and typical applications of Injection moulding-Plunger and screw machines-Blow moulding-Rotational moulding, Extrusion-Typical industrial applications, Thermoforming-Processing of Thermosets-Working principles and typical applications-Compression moulding-Transfer moulding.

1 **3 Hours**

EXPERIMENT 1

Study and practice of orthogonal and oblique cutting on lathe

2 **3 Hours**

EXPERIMENT 2

Measurement of cutting forces acting on the tool using dynamometer

3 **3 Hours**

EXPERIMENT 3

Making of hexagonal component using special lathes

4 **3 Hours**

EXPERIMENT 4
Making of stepped pulley using CNC machines

5 **3 Hours**

EXPERIMENT 5
Making of sheet metal component using shearing and bending operation

6 **3 Hours**

EXPERIMENT 6
Drawing of cup shaped product from sheet metal

7 **3 Hours**

EXPERIMENT 7
Preparation of solid component using sintering process

8 **3 Hours**

EXPERIMENT 8
Cutting operation of cast iron using wire cut EDM

9 **3 Hours**

EXPERIMENT 9
Preparation of simple component using Injection moulding process

10 **3 Hours**

EXPERIMENT 10
Moulding of simple component using thermoset / thermoplastic materials.

Total: 75 Hours

Reference(s)

1. SeropeKalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education Limited., New Delhi, 7e, 2018.
2. S. K. Hajra Choudhury, Elements of Workshop Technology. Vol. II, Media Promoters & Publishers Private Limited., Mumbai, 2013.
3. P. N. Rao, Manufacturing Technology- Metal Cutting and Machine Tools, Tata McGraw Hill Publishing Company Private Limited., New Delhi, 2017
4. J. P. Kaushish, Manufacturing Processes, Prentice Hall India Learning Private Limited., New Delhi, 2013.
5. V. K. Jain, Advanced machining processes, 1st Edition, Allied publishers, 2010
6. http://nptel.ac.in/courses/112105126/1

18AU307 AUTOMOTIVE COMPONENTS LABORATORY

0 0 2 1

Course Objectives

- To experience the skill of dismantling and assembling of engines.
- To optimize the combustion process in SI and CIengines.
- To understand the requirements of fuel systems in automobile vehicle.
- To examine the malfunctioning of thesystem.
- To understand the mounting of components, the basic working principle of components with the engine for accurate operations.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

m. An ability to design, analyze and find the solutions for automotive relatedproblems

Course Outcomes (COs)

1. Select the type of automobile engine based on construction, shape andapplication.
2. Compare petrol and diesel fuel supply systems in modernautomobiles.
3. Explain the procedure for dismantling differential and clutch invehicles.
4. Demonstrate front and rear axles and steering systems.
5. Select the suitable gear box and determine the gear ratio for automobile vehicles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			2	2	3							1	2	
2	2			2	3									
3			2	2	3							1	3	
4				2	2									
5				2	3								2	

1 **4 Hours**

EXPERIMENT 1

Dismantling and study of Multi-cylinder Petrol Engine

2 **2 Hours**

EXPERIMENT 2
Assembling of Multi-cylinder Petrol Engine

3 **4 Hours**

EXPERIMENT 3
Dismantling and study of Multi-cylinder Diesel Engine

4 **2 Hours**

EXPERIMENT 4
Assembling of Multi-cylinder Diesel Engine

5 **2 Hours**

EXPERIMENT 5
Measurement of light Vehicle Frame

6 **4 Hours**

EXPERIMENT 6
Exercise on dismantling and assembling of front, rear axles and determination of differential gear ratio.

7 **4 Hours**

EXPERIMENT 7
Exercise on brake adjustment and brake bleeding of braking system

8 **2 Hours**

EXPERIMENT 8
Exercise on adjustment of slipping, grabbing, dragging, pedal pulsation of clutch.

9 **4 Hours**

EXPERIMENT 9
Exercise on dismantling and determining the gear ratio of synchromesh gear box

10 **2 Hours**

EXPERIMENT 10
Measurement of steering ratio, steering angle and turning radius of steering system

Total: 30 Hours

18AU308 AUTOMOTIVE COMPONENTS DRAWING LABORATORY

0 0 2 1

Course Objectives

- To impart the knowledge of limits, fits and tolerances, orthographic-sectional and assembly drawing procedures.
- To apply different sectional views in engineering drawing.
- To recognize the drawing notations of standard machineelements.
- To provide the practice to draw assembly orthographic views of various machine parts usedin industry.
- To provide the training to convert the detailed part drawing from physicalproducts.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Select fits, limits and tolerance for engineering applications.
2. Identify sectional view, assembly and orthographic concepts to draw various automotive parts.
3. Select and draw the standard mechanical elements like bolt, nut, screw etc.
4. Select the assembly drawing of automobile and mechanical components.
5. Identify the drawing notations of standard automotive elements and draw the detailed drawing of a given components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2		2				2				2	
2	3		3		2				2				2	
3	3		2		3				2				3	
4	2		2		2				3				2	
5	2		3		2				2				2	

UNIT 1 **5 Hours**

LIMITS, FITS AND TOLERANCES

Limit System- Tolerance, Limits , Deviation, Actual Deviation , Upper Deviation , Lower Deviation- Allowance , Basic Size , Design Size , Actual Size- Fits- Types, Tolerances of Form and Position- Form and Position Variation, Geometrical dimensioning and Tolerance - Tolerance Zone, Indicating Geometrical Tolerances-Indication of Surface Roughness, Standard Abbreviations and Symbols used in industries.

UNIT 2 **5 Hours**

AUTOMOTIVE ELEMENT DRAWINGS

Drawing standards and Designation -Bolts, nuts, screws, keys, pins, Rivets, Welded Joints-Dimensioning of Welds, Belt Driven Pulleys, Chain and Gears Drives.

UNIT 3 **5 Hours**

SECTIONAL VIEWS

Sections- Hatching of Sections, Cutting Planes- Revolved or Removed Section- Sectional Views- Full Section, Half Sections and Auxiliary Sections- Conventional Representation.

UNIT 4 **8 Hours**

ASSEMBLY DRAWINGS

Manual parts drawing and assembled sectional views from orthographic part drawings -Automobile components- Single plate clutch, Multi plate clutch, Fuel Injector, Piston -Preparation of Bill of materials and tolerance data sheet. (Diagrams are not available for covering all the components)

UNIT 5 **7 Hours**

REAL PRODUCTS TO MACHINE DRAWING CONVERSION

Manual part drawings - assembled sectional views- Vice, Fork, Cotter Joint, Knuckle Joint, Belt Driven Pulley - Preparation of Bill of materials and tolerance data sheet.

Total: 30 Hours

Reference(s)

1. N.D. Bhatt, Machine Drawing,CharotarPublishing House Pvt. Ltd., 2014
2. P.S.Gill, A Text Book of Machine Drawing,Katson books, 2013
3. R.K.Dhawan, A Text Book of Machine Drawing,S.Chand,2012
4. K.C. John, Textbook of Machine Drawing,PHI Learning Pvt. Ltd.,2009

18GE301 SOFT SKILLS - VERBAL ABILITY 0 0 2 0

Course Objectives

- To help students gain adequate proficiency invocabulary
- To read and understand unabridged text
- To help students become proficient in basic writing skills related to work placecommunication

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Course Outcomes (COs)

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplacecommunication
3. Distinguish fact from opinion by reading passages from atext

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										1				
2											2			
3									2					

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

Total: 30 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books. 1991.
3. Baron"s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

18AU401 ENGINEERING MATHEMATICS IV 3 1 0 4

Course Objectives

- Understand the methods to solve polynomial equations and Implement the mathematical ideas for interpolation numerically.
- Summarize and apply the methodologies involved in solving problems related to ordinary differential equations
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supportingenvironment

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Classify the equations into algebraic, transcendental or simultaneous and apply the techniques to solve them numerically.
2. Find the interpolation, differentiation and integration of functions using the numericaltechniques.
3. Compute the solutions of ordinary differential equations, numerically.
4. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
5. Compute the occurrence of numerical errors.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	1												
3	1	2												
4	1	2												
5	2	2												

UNIT I **11 Hours**

ALGEBRAIC, SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS

Solution of algebraic and transcendental equations: Newton- Raphson method - Solution of system of linear equations: Gauss elimination method - Inverse of a matrix: Gauss-Jordan method- Eigen values of a matrix by Power method.

UNIT II **9 Hours**

INTERPOLATION, DIFFERENTIATION AND INTEGRATION

Interpolation: Newtons forward and backward interpolation formulae - Numerical differentiation: Newtons forward and backward interpolation formulae. Numerical integration: Trapezoidal rule- Simpsons rules for single integrals- Two point Gaussian quadrature formula.

UNIT III **9 Hours**

INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

Single step Methods : Taylor Series method for solving first order equations - Eulers and Modified Eulers methods - Fourth order Runge-Kutta method for solving first order equations - Multistep methods : Milnes predictor and corrector methods.

UNIT IV **11 Hours**

MATHEMATICAL STATISTICS

Sample mean and variance - Sampling distributions - Statistical estimation of parameters - confidence intervals - Testing of hypotheses : one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

UNIT V **5 Hours**

ERROR ANALYSIS

Errors, Truncation and round off errors, measurement errors, Chebychevs Polynomial and data filtering.

Total: 60 Hours

Reference(s)

1. Greenberg Michael D., Advanced Engineering Mathematics, Prentice-Hall International Inc, 2 nd Edition 1998.
2. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 4th Edition 2011.
3. KreyszigErwin, Advanced Engineering Mathematics, 10th Edition, John Wiley, 2011.
4. Grewal B. S, Numerical Methods in Engineering and Science with Programms in C & C++, Ninth Edition, Khanna Publications, 2010.
5. https://nptel.ac.in/syllabus/syllabus.php?subjectId=111107062

18AU402 STRENGTH OF MATERIALS 2 1 2 4

Course Objectives

- To estimate the stress distribution and strains in regular and composite structures subjectedto axial loads and thermal effects.
- To analyse two dimensional stress systems and stresses in thincylinders.
- To draw shear force, bending moment diagrams and evaluate the bending stress in different beams under transverse loading.
- To impart knowledge on finding slope and deflection of beams and buckling of columnsfor different boundary conditions.
- To design shafts and helical springs based on theory of torsion.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Determine the axial stresses and strains developed due to mechanical and thermal effects.
2. Analyze the stresses induced in two dimensional stress system and the thincylinders.
3. Determine the shear force, bending moment, bending stresses for various beams under different loading conditions.
4. Compute the deformation of beams and columns under static equilibrium conditions.
5. Analyze the stresses induced in the shaft and helicalsprings.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2										1	
2	2	3	2										2	
3	2	3	1										2	
4	2	3	1										2	
5	1	2	3										2	

UNIT I **6 Hours**

STRESS, STRAIN AND DEFORMATION OF SOLIDS

Introduction to mechanical properties-Hardness, Impact, Tensile, Compression, Torsion. Stresses and strains due to axial force in Stepped and Composite bars, Stresses due to thermal effect in composite bars, Stress-strain curve for ductile and brittle materials - Hooke""s law - Factor of safety - Poisson""s ratio. Elastic constants and their relationship.

UNIT II **6 Hours**

STRESSES IN TWO DIMENSIONS

State of stresses at a point, Normal and shear stresses on inclined planes, Principal planes and Principal stresses, Plane of maximum shear stress, analytical and graphical method. Hoop and longitudinal stresses in thin cylindrical vessels, Maximum Shear stress, Changes in dimensions and volume.

UNIT III **6 Hours**

SHEAR FORCE, BENDING MOMENT AND STRESSES IN BEAMS

Types of supports, Loads and beams, Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads, maximum bending moment and Point of contraflexure. Theory of Simple Bending, Bending stress and stress variation along the length and section of the beam, Sectionmodulus.

UNIT IV **6 Hours**

DEFLECTION OF BEAMS AND COLUMNS

Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay""s method.Types of Columns, Equivalent length, Euler and Rankine""s formulae, Slenderness ratio.

UNIT V **6 Hours**

TORSION IN SHAFT AND HELICAL SPRING

Theory of torsion and assumptions - torsion equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft. Closed coil helical spring-stresses and deflection under axial load, Maximum shear stress in spring section including Wahl"s Factor.

1 **3 Hours**

EXPERIMENT 1

Find the hardness of the materials used in Gears, Brake parts using Rockwell hardness tester.

2 **3 Hours**

EXPERIMENT 2

Calculate the hardness of the materials used in crank shaft, cams using Brinell hardness tester.

3 **3 Hours**

EXPERIMENT 3

Calculate the hardness of the materials used in piston, cylinder using Vickers hardness tester.

4 **3 Hours**

EXPERIMENT 4

Plot stress-strain curve by observing the tensile behaviour of the materials used in piston, vehicle body.

5 **3 Hours**

EXPERIMENT 5

Study the deflection of an axles and chassis frames under simply supported beam concept and compare the experimental values of deflection with the theoretical values.

6 **3 Hours**

EXPERIMENT 6
Determine the compressive strength of the materials used in connecting rod, piston.

7 **3 Hours**

EXPERIMENT 7
Calculate the strains in cylinders subjected to internal pressure through thin cylinder test setup.

8 **3 Hours**

EXPERIMENT 8
Experimentally calculate the strain energy of Bumper material subjected to impact loading.

9 **3 Hours**

EXPERIMENT 9
Determination of spring constant for suspension springs, Valve springs through load vs deflection curve.

10 **3 Hours**

EXPERIMENT 10
Experimental analysis of a materials used in Torsion bars, Propeller shafts under torsion to obtain stiffness and angle of twist.

Total: 75 Hours

Reference(s)

1. Hibbeler R.C, Mechanics of Materials, Pearson Education, New Jersey, 2018.
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India Learning Pvt Ltd, New Delhi, 2010.
3. F. P. Beer and R. Johnston, Mechanics of Materials, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2015.
4. S.S.Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, Third Edition, 2017.
5. S.S.Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, Fourth edition, 2013
6. https://onlinecourses.nptel.ac.in/noc18_ce17/preview

18AU403 AUTOMOTIVE TRANSMISSION 3 0 0 3

Course Objectives

- To explain the concept of torque multiplication by gears and torqueconverters
- To acquire knowledge on concept, construction and principle of operation of mechanical, hydrodynamic, hydrostatic devices and automatic transmission systems
- To understand the purpose of clutch, gear box, fluid coupling and hydraulic systemsin automotive transmission.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Appraise the needs and functions of transmission system inautomobiles.
2. Select appropriate clutch from different types of Clutches used inautomobiles.
3. Choose appropriate gearbox from different types of manual gearbox used in automobiles.
4. Analyze hydrodynamic and hydrostatic transmission with performance parameter.
5. Choose appropriate automotive gearbox for modern automobiles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2										2	
2	2	3	2										2	
3	1	3		2									3	
4	1	3		2									2	
5	2	3	2										3	

UNIT I **9 Hours**

INTRODUCTION

Need for Transmission system, Components in transmission system, Types of Transmission system, Tractive Effort and Resistances to Motion of a vehicle, Requirements and Classification of Transmission systems. Objective and need of the Gear Box, Determination of gear ratios for vehicles, Performance characteristics in different speeds, Power and economy modes in gearbox.

UNIT II **9 Hours**

CLUTCH

Clutches- requirement, types, principle of friction clutch, construction and operation of Single plate coil spring, Diaphragm spring clutches, Multiplate clutch, Cone clutch, Electromagnetic clutch, Centrifugal and Semi-Centrifugal Clutch, dry and wet type of clutch, Friction lining materials.

UNIT III **9 Hours**

MANUAL GEARBOX

Gear boxes -Sliding, Constant and Synchromesh type, Transfer box, Transaxles, Overdrives, Gear shifting mechanisms, Sequential, Selective Gearbox, Mechanical link and wire types.

UNIT IV **9 Hours**

HYDRAULIC TRANSMISSION

Fluid coupling- principle of operation, construction, performance characteristics, Torque converter- principle of operation, construction, performance characteristics, Multistage torque converters and Polyphase torque converters. Hydrostatic drives- principle, advantages & limitations, Janny hydrostatic drive- construction and working.

UNIT V **9 Hours**

AUTOMATIC TRANSMISSION

Epicyclic gearboxes - Gear Ratio calculation, Automatic transmission- merits and demerits, Typical automatic transmissions - Wilson gearbox, Chevy turboglide, Automated Manual transmission, Dual Clutch transmission, Continuously varying Transmission, Modern Transmission techniques.

Total: 45 Hours

Reference(s)

1. Newton and Steeds, Motor vehicles, London: Illife Publishers, 2002.
2. Heldt .P.M, Torque converters, Pennsylvania: Chilton Book Co., 2014.
3. Judge.A.W. Modern Transmission systems, London: Chapman and Hall Ltd, 2000.
4. Heisler. H, Advanced Vehicle Technology, Oxford: Butterworth Heinemann, 2002.

18AU404 AUTOMOTIVE MECHANICS 2 1 2 4

Course Objectives

- To acquire knowledge on the principles in the kinematics of mechanisms and static forces.
- To provide knowledge on the balancing of systems based on dynamic analysis fordifferent mechanisms.
- To design gears and cams for modern automobiles.
- To appreciate the effect of fuel governing mechanisms and gyroscopic effects.
- To analyze the forces and vibrations of simple mechanicalsystems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. An ability to design, analyze and find the solutions for automotive relatedproblems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Analyse the static forces acting on simple mechanisms
2. Analyse the dynamic forces for balancing of the mechanism
3. Categorize the mechanism involved in cam and geartrain
4. Analyse the effect of fuel governing mechanism and gyroscopic mechanism
5. Inspect the system to reduce thevibration

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2										3	3
2	3	3	2		2								3	3
3	3	3	3		3								3	
4	3	3	3		3								3	
5	3	3	3		-								3	

UNIT I **6 Hours**

MECHANISM AND STATIC FORCE ANALYSIS

Machine , Structure - Kinematic link, pair and chain - Constrained motion - Degrees of freedom - Grueblers and Kutzback criteria - Inversions of Four bar mechanism and Inversion of single & double slidercrank mechanisms - Forces - Applied and Constraint-Free Body Diagrams-Static equilibrium conditions; two, three and four force members-Static force analysis in simple mechanisms.

UNIT II **6 Hours**

DYNAMIC FORCE ANALYSIS AND BALANCING

Inertia force and torque-D"Alemberts Principle-Dynamic force analysis in Reciprocating engine: Gas force, Equivalent mass, Bearing Loads, Crank shaft torque-Engine shaking forces-Ackermann Steering mechanism

Static and dynamic balancing-Balancing of rotating and reciprocating masses.

UNIT III **6 Hours**

CAM AND GEAR MECHANISMS

Cams -Types of cams - Design of profiles - Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.
Gear terminology, types of gears, law of gearing -Nomenclature of spur and helical gears - Gear trains: simple, compound gear trains and epicylic gear trains.

UNIT IV **6 Hours**

GOVERNING AND GYROSCOPIC MECHANISM

Governors: working principle, types, construction, sensitivity, controlling force-Gyroscopic principle-Gyroscopic couple-Centrifugal couple-effect on four wheeled vehicles-Gyroscopic forces, torques and stabilization.

UNIT V **6 Hours**

FUNDAMENTALS OF VIBRATION

Terminologies, types of vibration, equation of motion -Free undamped vibration, free damped vibration - Damping ratio, damping coefficient, logarithmic decrement, critical speed - Torsional vibration -Single, two and three rotor system.

1 **3 Hours**

EXPERIMENT 1

Analyse the four bar mechanism for simple forces

2 **3 Hours**

EXPERIMENT 2

Analyse the crank and slider mechanism for simple forces

3 **3 Hours**

EXPERIMENT 3

Analyse the Ackerman steering mechanism used in an automobile

4 **3 Hours**

EXPERIMENT 4

(i) Balance a system of rotating masses at single and different planes
(ii) Balance a system of reciprocating masses

5 **3 Hours**

EXPERIMENT 5

Generate the cam profile for a typical automotive engine

6 **3 Hours**

EXPERIMENT 6
Generate the profile of a spur gear and helical gear for automotive application

7 **3 Hours**

EXPERIMENT 7
Compute the sensitivity and controlling force of an automotive fuel governor

8 **3 Hours**

EXPERIMENT 8
Analyse the gyroscopic effect on a two wheeler

9 **3 Hours**

EXPERIMENT 9
Compute a method to reduce vibration in a two rotor system

10 **3 Hours**

EXPERIMENT 10
Compute a method to reduce vibration in a three rotor system

Total: 60 Hours

Reference(s)

1. Shigley J.E. and Uicker J.J., Theory of Machines and Mechanisms, McGraw Hill. Inc., 2017.
2. S.S. Rattan, Theory of Machines, Tata McGraw-Hill Publishing Co., New Delhi, 2014.
3. S.S. Rao, Mechanical Vibrations, Prentice Hall of India, New Delhi, 2017.
4. Thomas Bevan, The Theory of Machines, Pearson Education, 2010.
5. https://nptel.ac.in/courses/112104121/

18AU405 APPLIED THERMODYNAMICS AND HEAT TRANSFER

3 1 0 4

Course Objectives

- To acquire knowledge on air compressors, gas turbines and their performance
- To apply the thermodynamic concepts to air compressors, refrigeration and air conditioning systems
- To build up necessary background for understanding the physical behavior of three modes of heat transfer

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyze Performance of the air compressors and gas turbines thermodynamically.
2. Apply thermodynamic principles and psychrometry to evaluate the performance of refrigeration and air conditioning systems
3. Analyze heat transfer by conduction in steady state systems, unsteady systems and fins for practical problems
4. Apply the convection and radiation heat transfer principles to practical problems.
5. Design and analyze the performance of heat exchangers.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3		3									3	
2	3	2		1									3	
3	2	3		2									2	
4	3	2	3	1									2	
5	2	3	3	1									3	

UNIT I **9 Hours**

AIR COMPRESSORS AND GAS TURBINES

Types-Work required-Effect of clearance volume, volumetric efficiency, isothermal efficiency, free air delivery- Multistage compression, condition for minimum work- Working principle of rotary compressor-Centrifugal Compressors.
Gas turbine plants - Open and closed cycles - Thermodynamic cycles - Regeneration, reheating, intercooling - Performance of gas turbines.

UNIT II **9 Hours**

REFRIGERATION AND AIR CONDITIONING

Vapour compression Refrigeration cycle - Effect of superheat, sub cooling of refrigerant - Performance calculations- Vapour absorption system-Ammonia- water and Lithium bromide water systems(Descriptiononly)

Air conditioning- Psychromterty of air conditioning systems- RSHF, GSHF, ESHF, Cooling and heating load calculations for typical automobiles- Air conditioning systems.

UNIT III **10 Hours**

CONDUCTION

Basic concepts - Mechanism of heat transfer - Conduction, convection and radiation - General differential equation of heat conduction - Fourier law of conduction - One dimensional steady state heat conduction - Conduction through plane wall, cylinders and spherical systems - Composite systems - Heat transfer from finned surfaces -Fins of uniform cross section- Fin efficiency and effectiveness-Unsteady heat conduction - Lumped analysis - Use of Heislers chart.

UNIT IV **8 Hours**

CONVECTION AND RADIATION

Basic concepts - Convective heat transfer coefficients - Boundary layer concept - Forced convection, dimensional analysis, external flow, flow over plates, cylinders and spheres - Internal flow, laminar and turbulent flow- Flow over bank of tubes - Free convection, dimensional analysis, flow over vertical plate and horizontal plate. Shape factor-Radiation shields -Gas radiation.

UNIT V **9 Hours**

HEAT EXCHANGERS

Single and multi tube heat exchangers - Parallel, counter and cross flow heat exchangers, overall heat transfer coefficient, LMTD and effectiveness (NTU) methods- Fouling factor - compact heat exchangers.

Total: 60 Hours

Reference(s)

1. Y.Cengel and M. Boles, Thermodynamics: An Engineering Approach, New Delhi: Tata McGraw- Hill Publishing Company, 2014.
2. T. D. Eastop and A. McConkey, Applied Thermodynamics for Engineering Technologists, New Delhi: Pearson Education, 2009.
3. P. K. Nag, Basic and Applied Thermodynamics, New Delhi: Tata McGraw- Hill Publishing Company, 2009.
4. T. L. Bergman, A. S. Lavine, F. P. Incropera and D. P. DeWitt, Fundamentals of Heat and Mass Transfer, New Jersey: John Wiley & Sons, 2011.
5. J.P. Holman, Heat transfer, New Delhi: Tata McGraw- Hill Publishing Company, 2008.
6. https://nptel.ac.in/courses/112101097/

18AU406 AUTOMOTIVE ELECTRICAL SYSTEM 3 0 0 3

Course Objectives

- To acquire knowledge on batteries and lighting systems
- To describe starting, charging, ignition and injection systems
- To understand the role of sensors and actuators invehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Select the appropriate Battery from different types of Battery used inautomobiles.
2. Access the performance of Lighting System used inautomobiles.
3. Analyze the Starting and Charging System with their performance used inautomobiles.
4. Analyze the Ignition System with their performance parameter used in automobiles.
5. Choose appropriate automotive Sensors and Actuators for modernautomobile

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1					1						2	
2	3	1	1										2	
3	2	3		1									2	
4	2	3		2									2	
5	3	1	2										2	

UNIT I **9 Hours**

LIGHTING SYSTEM

Lighting System - insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods, anti-dazzling and dipper details, Smart lighting system, Dashboard instruments. Selection of Fuses, cables, connectors; multiplexing and de-multiplexing. Automotive wiring system.

UNIT II **9 Hours**

ELECTRICAL DEVICES

Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids, Charging system components, Generators and Alternators types, construction and Characteristics. Voltage and Current Regulation, cut Ã¢??out relays and regulators, Charging circuits for D.C. Generator, A.C. Alternators.

UNIT III **9 Hours**

SENSORS

Microprocessor architecture, open and closed loop control strategies, Inductive, Hall effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Throttle position, air mass flow, crank shaft position, cam position, engine and wheel speed, fuel level, exhaust oxygen level, knock, engine temperature, manifold temperature and pressure sensors. Infrared sensors, Ultra sonic sensors, LIDAR, RADAR, voltage sensor.

UNIT IV **9 Hours**

SAFETY SYSTEMS

ABS system-layout and working. Electronic control of suspension, Electric power steering, Supplementary Restraint System of air bag system-crash sensor, seat belt tightening. Cruise control. Vehicle security systems- alarms, vehicle tracking system. On board diagnostics. Collision avoidance Radar warning system.

UNIT V **9 Hours**

E MOBILITY

Power grids- Definition, sources for power grid, Types. Battery Management system- need for BMS, battery heat problems, over charging and undercharging problems. Electric motors- BLDC, Induction motors, Difference between BLDC and Induction motors. Electric drives- AC drives, DC drives.

Total: 45 Hours

Reference(s)

1. Robert Bosch, Automotive Handbook, Bentley Publishers, 2011
2. Tom Denton, Automobile Electrical and Electronic Systems, UK:Taylor & Francis Ltd,V edition,2017
3. Ali Emadi,Advanced Electric Drive Vehicle, McMaster University, Hamilton, Ontario, Canada, 2017.
4. Austin Huges and Bill Drury, Ã¢??Electric Motors and Drives fundamentals, types and applicationsÃ¢??,4th Edition.

18AU407 AUTOMOTIVE ELCTRICAL LABORATORY 0 0 2 1

Course Objectives

- To acquire skills in inspecting and testing vehicle electricalsystems.
- To acquire knowledge on vehicle wiring.
- To acquire skills in diagnosis of ignition systemfailures.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Perform inspection on headlights, horn and sidelamps
2. Perform and inspect various tests on batteries, starter motor and alternator
3. Interface analog sensors to micro controller to perform automaticoperations.
4. Perform simple data acquisition from automotivesystem
5. Perform inspection on motor drives and power grids.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1				3		1		2				2	
2	2	2			3		2		2				2	
3	2	1			3		1		2				2	
4	2	2			2		2		2				2	
5	2	2			3		2		2				2	

1 **3 Hours**

EXPERIMENT 1

Connection and observation of headlights, horn and sidelamps.

2 **3 Hours**

EXPERIMENT 2

Demonstration of Automobile electrical wiring Testing of battery with hydrometer and high rate discharge tester

3 **3 Hours**

EXPERIMENT 3
Testing of starting motors.

4 **3 Hours**

EXPERIMENT 4
Testing of generators

5 **3 Hours**

EXPERIMENT 5
Construction and observation of obstacle sensors.

6 **3 Hours**

EXPERIMENT 6
Construction and observation of Powertrain sensors.

7 **3 Hours**

EXPERIMENT 7
Testing of battery with hydrometer and high rate discharge tester

8 **3 Hours**

EXPERIMENT 8
Charging characteristics of Battery

9 **3 Hours**

EXPERIMENT 9
Observation of motor drives.

10 **3 Hours**

EXPERIMENT 10
Study of Power and power grids

Total: 30 Hours

Reference(s)

1. P.L.Kohli, Automotive Electrical Equipment, New Delhi: Tata McGraw-Hill Education co ltd, 2004.
2. W.H.Crouse, Automobile Electrical Equipment, NY: McGraw-Hill Book Co Inc, 2005.
3. T.Denton, Automotive Electrical and Electronic System, UK: Elsevier Butterworth-Heinemann, 2004.

18AU408 THERMO FLUIDS ENGINEERING LABORATORY

0 0 2 1

Course Objectives

- To apply the theoretical and analytical skills acquired in thermodynamics, fluid mechanicsand heat transfer to laboratory experiments
- To evaluate the performance of air compressors, refrigeration systems, air conditioningsystems and pumps
- To analyze the heat transfer characteristics of parallel and counter flow heat exchangers

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Compute the coefficients of flow measuring devices.
2. Compute the friction losses in pipes.
3. Evaluate the performance of two stage reciprocating air compressor, positive displacement pump, refrigerator and air conditioning systems
4. Calculate the thermal conductivity of metals, the heat transfer coefficients offree and forced convection
5. Evaluate the performance characteristics of heat exchanger

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		2					2				2	
2	2	3		1					2				2	
3	2	3	1	2					2				3	
4	3	2	1	2					2				1	
5	2	3		1					2				3	

1 **4 Hours**

EXPERIMENT 1

Fluid flow measurements using venturimeter, orificemeter and pitot tube

2 **2 Hours**

EXPERIMENT 2
Determination of friction losses in piping systems

3 **2 Hours**

EXPERIMENT 3
Determination of performance characteristics of positive displacement pump

4 **4 Hours**

EXPERIMENT 4
Determination of volumetric efficiency and overall efficiency of reciprocating air-compressor

5 **2 Hours**

EXPERIMENT 5
Determination of co-efficient of performance and ton of refrigeration of vapour compression refrigeration system

6 **4 Hours**

EXPERIMENT 6
Determination of co-efficient of performance and ton of refrigeration of air conditioning system

7 **2 Hours**

EXPERIMENT 7
Determination of thermal conductivity of metal rod

8 **4 Hours**

EXPERIMENT 8
Experimental study of heat transfer by natural convection

9 **4 Hours**

EXPERIMENT 9
Experimental study of heat transfer by forced convection

10 **2 Hours**

EXPERIMENT 10
Determination of performance characteristics of double pipe heat exchanger

Total: 30 Hours

Reference(s)

1. P. K. Nag, Basic and Applied Thermodynamics, New Delhi: Tata McGraw- Hill Publishing Company, 2016.
2. T. D. Eastop and A. McConkey, Applied Thermodynamics for Engineering Technologists, New Delhi: Pearson Education, 2009.
3. T. L. Bergman, A. S. Lavine, F. P. Incropera and D. P. DeWitt, Fundamentals of Heat and Mass Transfer, New Jersey: John Wiley & Sons, 2011.
4. P. K. Nag, Heat and Mass Transfer, New Delhi: Tata McGraw- Hill Publishing Company, 2011.
5. Y. Cengel and J. Cimbala, Fluid Mechanics Fundamentals and Application, Tata McGrawHill Publishing Company Pvt Ltd., New Delhi 2009.
6. P.Purusothamaraj and V.Ramasamy, Fluid Mechanics and Machinery,Scitechpublications (India) Pvt.Ltd, Chennai, 2012.

18HS001 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life andstimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Explain the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Identify the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate the impacts of population and human activities onenvironment

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2												
2	1	1												
3	2	2					1							
4	1													
5	2													

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods Ã¢?? earthquake

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste.

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

FOR FURTHER READING

Human rights:Biomedical waste -Identification of adulterants infoodmaterials

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and PollutionScience. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, NewDelhi, 2014

18GE401 SOFT SKILLS-BUSINESS ENGLISH 0 0 2 0

Course Objectives

- To acquire command ofboth the receptive skills (Listening, Reading) and the productiveskills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									1					
2										2				

UNIT I **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information

Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 30 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

21AU501 METROLOGY AND MEASUREMENTS 3 0 2 4

Course Objectives

- To understand the objectives of metrology and the concept of measurement.
- To explain the measurement techniques on linear and angular measurements.
- To describe the measurement techniques on gear, thread and radial profiles.
- To provide knowledge on recent trends in metrology and measurements.
- To deliver the various measurement techniques of mechanical parameters

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Explain the characteristics of measuring instruments and errors in measurements.
2. Select the suitable linear measuring instruments for measuring the component dimensions like piston pin, piston rings and crank shaft.
3. Choose the appropriate measuring instruments to measure the critical dimensions of screw threads and gears.
4. Find the suitable optical measuring instrument to measure flatness, squareness and surface roughness of the given component.
5. Show the suitable measuring instrument to measure force, power, pressure andtemperature parameters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	2		2								2	
2	2	3	2		2				2				3	
3	2	3	2		2				2				3	
4	2	3	2		2				2				2	
5	2	3	2		2				2				3	

UNIT I **4 Hours**

CONCEPT OF MEASUREMENT

Introduction: Definition, Objectives, Need for Inspection, Elements of Measuring System, Accuracy and Precision - Units and Standards - Characteristics of measuring instrument: Sensitivity, Stability, Interchangeability, Range of accuracy, Readability, Reliability, Backlash, Repeatability and Reproducibility - Errors in Measurements: Static and dynamic errors - Calibration of Measuring Instruments - Care of Measuring Instruments.

UNIT II **6 Hours**

LINEAR AND ANGULAR MEASUREMENTS

Linear Measurements: Vernier Caliper, Vernier Height and Depth Gauges, Micrometer and depth micrometer, Slip gauge, limit gauge and its classification - Comparator: Mechanical, Pneumatic and Electrical types - Angular Measurements: Bevel protractor, Sine bar, Angle Decker, Autocollimator.

UNIT III **8 Hours**

FORM MEASUREMENT

Thread Measurement: Terminologies, Errors - External Thread Measurement: Pitch Gauge, Tool Makers microscope, Floating Carriage micrometer with One, Two and Three wires - Internal Thread Measurement: Taper Parallels and Rollers method. Gear Measurement: Terminologies, Errors, Gear Tooth Vernier caliper, Profile Projector, Base pitch measuring instrument, David Brown Tangent Comparator, Involute tester, Parkinson Gear Tester - External and Internal Radius measurements - Roundness measurement: Circumferential confining gauge, Assessment using V block and Rotating centers.

UNIT IV **6 Hours**

LASER AND ADVANCES IN METROLOGY

Interferometer: NPL Flatness, Laser, Michelson-Laser gun - Computer Aided Inspection - Digital Devices - Machine Vision System - Coordinate Measuring Machine: Basic concept, Types, Constructional features, Probes, Accessories - 3D scanner with blue light technology - Surface Roughness Measurement - Straightness Measurement -Squareness Measurement - Machine Tool Metrology.

UNIT V **6 Hours**

MEASUREMENT OF MECHANICAL PARAMETERS

Measurement of Force - Principle, platform balance, proving ring. Torque - Prony brake, hydraulic dynamometer, eddy current dynamometer and DC dynamometers Ã¢?? Tachometer - Pressure Measurement: Principle, use of elastic members, Bridgeman gauge, Mcleod gauge, Pirani gauge, Piezo-electric pressure pickup - Temperature Measurement: bimetallic strip, thermocouples, metal resistance thermometer, pyrometers- Introduction to Nanometrology.

1 **4 Hours**

EXPERIMENT 1

Comparing the accuracy of vernier caliper, vernier height gauge and micrometer to check the various dimensions of given automobile components.

2 **2 Hours**

EXPERIMENT 2

Checking the dimensional limits of ten similar automobile components using mechanical comparator.

3 **4 Hours**

EXPERIMENT 3
Measurement of taper angle of a given specimen by direct and indirect method.

4 **4 Hours**

EXPERIMENT 4
Measurement of screw thread specifications by using tool makers microscope.

5 **4 Hours**

EXPERIMENT 5
Measurement of gear tooth specifications by using Gear tooth verniercalliper / Tool maker microscope / Profile projector / Parkinson gear rolling tester.

6 **2 Hours**

EXPERIMENT 6
Measurement of surface finish of a given automobile component using profilometer.

7 **2 Hours**

EXPERIMENT 7
Measurement of dimensions of a given automobile component using Coordinate measuring machine.

8 **4 Hours**

EXPERIMENT 8
Measurement of straightness of a given automobile component by using Autocollimator and Interferometer.

9 **2 Hours**

EXPERIMENT 9
Machine tool alignment test on Lathe / Milling machine / Drilling machine.

10 **2 Hours**

EXPERIMENT 10
Temperature measurement by using Bimetallic strip / Thermocouples / Pyrometer.

Total: 60 Hours

Reference(s)

1. Beckwith, Marangoni, Lienhard, Mechanical Measurements, Pearson Education , 2014.
2. Bewoor and Vinay Kulkarni, Metrology & Measurement, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi,2009.
3. Alan S. Morris, The Essence of Measurement, Prentice Hall of India, New Delhi,2001
4. R. K. Jain, Engineering Metrology, 21e, Khanna Publishers, New Delhi, 2016.
5. A. K. Jayal, Instrumentation and Mechanical Measurements, Galgotia Publications, NewDelhi 2000.
6. www.nptel.ac.in/courses/112104250

21AU502 DESIGN OF AUTOMOTIVE ENGINE COMPONENTS

3 1 0 4

Course Objectives

- To understand the stresses induced in machine components by different types ofloads.
- To familiarize the various steps involved in the design process.
- To understand the principles involved in evaluating the shape and dimensions of an automotive engine component to satisfy functional and strengthrequirements.
- To learn to use standard practices and standarddata.
- To learn to use catalogues and standard machinecomponents.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Compute the stresses caused by different types of loads and theories of failure to design commonly used machine components.
2. Calculate the dimensions of cylinder, mountings, piston components and valve of an IC engine.
3. Analyse the design parameters of connecting rod andcrankshaft
4. Analyse the design parameters of flywheel and bearings
5. Compute the fuel system design parameters based on the engine performancerequirement

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												2	
2	3	3	3					3			3		3	
3	3	3	3					3			3		3	
4	3	3	3					3			3		3	
5	3	3	3					3			3		3	

UNIT I **9 Hours**

INTRODUCTION

Introduction to the design process-Selection of Materials Based on Mechanical Properties, stresses due to eccentric loading, Design of straight and curved beams - "C" frame and crane hook. Stress concentration - Design for variable loading - Soderberg, Goodman, Gerber methods and Principal Stresses in members subjected to combination of static loads- Theories of failure.

UNIT II **9 Hours**

DESIGN OF CYLINDER, PISTON COMPONENTS AND VALVES

Design of cylinder wall-liner-cylinder head-calculations-engine mountings and types - Piston components-choice of material-gas force calculation-piston, piston pin, and piston rings design calculation-piston slap-piston failures. Valve train components-valves-types-materials-design calculation.

UNIT III **9 Hours**

DESIGN OF CONNECTING ROD AND CRANKSHAFT

Connecting rod-material-determining minimum length-small end design-shank design-design of big end cap bolts. Crankshaft-IC engines balancing-firing order-significance-material-design of crankshaft under bending and twisting.

UNIT IV **9 Hours**

DESIGN OF FLYWHEELS AND BEARINGS

Mass of a flywheel-coefficient of speed fluctuation-engine flywheel-stresses on the rim-Design of hubs and arms of the flywheel-turning moment diagram. Types and selection criteria - Design of journal bearings, collar bearing - Design of rolling contact bearing - Ball and roller bearing.

UNIT V **9 Hours**

DESIGN OF FUEL SYSTEM

SI engine-carburettor-venturi main jet-compensating jet-calculations. CI engine-fuel injection pump-theoretical fuel delivery-plunger diameter-complete plunger stroke-plunger active stroke-injector-fuel discharge time-mean velocity of fuel discharge-nozzle hole diameter.

Total: 60 Hours

Reference(s)

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, Tata McGraw - Hill Publishing Company Pvt. Ltd., New Delhi, 2017.
2. V.B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Education, 2017.
3. Khurmi. R.S. and Gupta. J.K., A Textbook of Machine Design, Eurasia Publishing House(Pvt) Ltd., 2005.
4. Richard van Basshuysen, Internal Combustion Engine Handbook, SAE International, 2004.
5. Kolchin and Demidov,Design of automotive engines, Mir Publishers Moscow, 1984.
6. http://www.nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Machine%20design1/New_index1.html

21AU503 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- To understand the concepts of Automotive Electronics and it"s evolution and trends
- To understand sensors and sensor monitoring mechanisms aligned to automotivesystems, different signal conditioning techniques, interfacing techniques and actuator mechanisms.
- To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software.
- To describe various communication systems, wired and wireless protocols used in vehicle networking.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Identify the current trends of automotive electronics systems
2. Analyse different control module of automotive engine.
3. Select appropriate automotive Sensors and Actuators for modern automobiles
4. Understand Interfacing of sensors and actuators usingRTOS
5. Analyse the communication protocol suitable forautomobile

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	3	3	3		3								3	
3	2												2	
4	3	3	2		3								3	
5	2												3	

UNIT I **9 Hours**

ELECTRONICS IN AUTOMOBILE

Introduction- Body and convenience electronics: vehicle power supply controllers and lighting modules, door control modules, Safety electronics: active safety systems: ABS, ASR, ESP passive safety systems: Restraint systems and their associated sensors in an automobile. Infotainment electronics: Dashboard/instrument cluster, car audio, telematics systems, navigation systems, multimedia systems.

UNIT II **9 Hours**

ELECTRONIC ENGINE CONTROLS

Concept of an electronic engine control system: - electronic fuel injection - throttle body fuel injection, multi point fuel injection, gasoline direct injection, common rail direct injection, electronic ignition control, engine mapping, on-board diagnostics-engine control module and power train control module.

UNIT III **9 Hours**

AUTOMOTIVE NEURAL NETWORKS

ANN-Definition, artificial and biological neuron, learning (supervised and unsupervised learning). (Unsupervised learning) McCulloh-Pitts neuron, Linear separability, Hebb network. (Supervised learning) Perceptron Network, Adaline, Medaline. Convolution Neural Networks- Feed Forward networks, Back propagation network.

UNIT IV **9 Hours**

REAL TIME OPERATING SYSTEM (RTOS)

Comparison of conventional OS with RTOS. Tasks & task states (Pre-emptive & Non-pre-emptive, scheduler, interrupt -Interrupt latency and context switch latency)-Task, multi-tasking, task synchronization, inter-task communication, shared data problem and its prevention - Features of a typical embedded RTOS (MuC/OS-II).

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction to control networking-Communication protocols in embedded systems-SPI, I2C, USB. Vehicle communication protocols-Introduction to CAN, LIN, FLEXRAY, MOST, AUTO SAR.

Total: 45 Hours

Reference(s)

1. Robert Bosch,Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, Springer Vieweg ,Plochingen, Germany, 2014.
2. William B Ribbens, Understnading Automotive Electronics- An Engineering Persepective, The Boulevard, Langford Lane, Kidlington, Oxford, 2017.
3. Barry Holembeak, Automotive Electricity and Electronics Delmar Publishers, Clifton Park, USA, 2010.
4. James D Halderman, Automotive Electricity and Electronics, Prentice Hall, USA, 2013.
5. Al Santini, Automotive Electricity and Electronics, Delmar Learning, 2011.
6. Charu C. Aggarwal Neural Networks and Deep Learning: A Text Book

21AU504 AUTOMOTIVE EMISSION AND CONTROL 3 0 2 4

Course Objectives

- To acquire knowledge on SI and CI engine emission
- To describe emission measurement, test procedure & regulations
- To apply control technologies for SI and CI engine emission

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Explain the emission scenario and sources of pollutants from vehicle
2. Analyze the causes, effects of pollutants from an S.Iengine
3. Analyze the causes, effects of pollutants from an C.Iengine
4. Indicate the emission controlling techniques used in anengine
5. Analyze the testing procedure methods for measuring emission in an engine

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2			2	2	2	2				2	
2	2	3					2	2	2				3	
3	2	2		2			1	2	2				2	
4	1	2		2	3		1	2	2				3	
5	2	3			2	3	2	2	2				3	

UNIT I **8 Hours**

INTRODUCTION

Automobile emission scenario-sources of emission from vehicle, contribution to pollution, Formation of pollutants- photochemical smog, primary and secondary pollutants, Effects on human health and environment- global warming, Types of emission, Transient operational effects on pollution.

UNIT II **9 Hours**

SI ENGINE EMISSION

Pollutant formation in SI Engines- HC and CO formation in four stroke and two stroke SI engines, NOx formation in SI engines, Effects of design and operating variables on emission formation- engine modifications, Effect of fuel properties and additives, Emissions from alternate fuels.

UNIT III **8 Hours**

CI ENGINE EMISSION

Pollutant formation in CI engines- smoke and particulate emissions in CI engines, Formation of HC and CO in CI engines-undermining and over mixing, NOx formation, Effects of design and operating variables on CI engine emissions- engine modifications.

UNIT IV **10 Hours**

EMISSION CONTROL TECHNIQUES

Add on systems to control emissions inside the engine- EGR, crankcase and evaporative emission control, Exhaust gas after treatment- secondary air injection, thermal and catalytic reactors, oxidation, reduction and 3-way catalytic reactors, lean de-NOx catalysts, NOx traps and SCR, Diesel particulate filters (DPF), DPF regeneration, CRT.

UNIT V **10 Hours**

EMISSION MEASUREMENT, TEST PROCEDURES

Instruments- non dispersive infrared (NDIR) analyzer, flame ionization detectors (FID), chemiluminescence analyzer, smoke meters, gas chromatograph, Test procedures - ECE, FTP Tests, SHED Test, chassis dynamometers, dilution tunnels, Trends in vehicle emission standards- emission limits, Driving cycles - USA, Japan, Euro and India.

1 **3 Hours**

EXPERIMENT 1

Case study on Emissions on Indian scenario

2 **4 Hours**

EXPERIMENT 2

Performance and emission tests on a two wheeler vehicle

3 **3 Hours**

EXPERIMENT 3

Performance and emission tests on automotive multi-cylinder SI engine

4 **3 Hours**

EXPERIMENT 4

Heat balance and Emission tests on automotive SI Engine

5 **3 Hours**

EXPERIMENT 5
Performance and emission tests on automotive multi-cylinder CI engine

6 **3 Hours**

EXPERIMENT 6
Heat balance and Emission tests on automotive CI Engine

7 **3 Hours**

EXPERIMENT 7
Performance and emission tests on automotive multi-cylinder CI engine with EGR

8 **3 Hours**

EXPERIMENT 8
Performance and emission tests on automotive multi-cylinder CI engine with Catalytic Converter

9 **3 Hours**

EXPERIMENT 9
Analyzing the combustion characteristics of automotive engines

10 **2 Hours**

EXPERIMENT 10
Case study on testing driving cycles followed in different countries.

Total: 75 Hours

Reference(s)

1. J.D. Halderman and J. Linder, Automotive Fuel and Emissions Control Systems, NJ: Pearson Education, 4th edition 2016.
2. B.P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, New Delhi: Narosa Publishing House, 2017.
3. M. Adachi and H. Nakamura, Eds., Engine Emissions Measurement Handbook, PA: SAE International, 2014.
4. M.K.Khair and W.A.Majewski, Diesel Emissions and Their Control, PA: SAE International, 2014.

21AU507 AUTOMOTIVE ELECTRONICS LABORATORY

0 0 2 1

Course Objectives

- To acquire knowledge on microprocessor and control strategies
- To acquire skills in inspecting and testing vehicle electrical and electronics systems
- To acquire knowledge on vehicle wiring and sensors
- To acquire skills in diagnosis of electronic systems

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
m. An ability to design, analyze and find the solutions for automotive relatedproblems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Perform sensor and actuator interfacing using PIC microcontroller.
2. Execute passenger door module control and repair.
3. Analyze sunroof module and electronic accelerator pedal
4. Analyze parameters of MPFI and CRDisystem
5. Determine diagnostics errors in vehicle using OBD

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2				2		2		3				2	3
2	2	3			2		2		3				3	3
3	2				2		2		3				2	3
4	2	3			2		2		3				3	3
5	2	3			2		2		3				3	3

1 **3 Hours**

EXPERIMENT 1

Perform LED Blinking, Digital Inputs and outputs using Microcontrollers

2 **3 Hours**

EXPERIMENT 2

Perform Interrupt, Buzzer and Input Capture using Microcontrollers

3 **3 Hours**

EXPERIMENT 3
Perform control of passenger door module.

4 **3 Hours**

EXPERIMENT 4
Control automotive central locking system

5 **3 Hours**

EXPERIMENT 5
Perform and control sunroof module

6 **3 Hours**

EXPERIMENT 6
Perform Electronic Accelerator pedal repair

7 **3 Hours**

EXPERIMENT 7
Determine parameters of MPFI and CRDi

8 **3 Hours**

EXPERIMENT 8
Perform control of lane assist system

9 **3 Hours**

EXPERIMENT 9
Analyze Electronic Suspension System

10 **3 Hours**

EXPERIMENT 10
Electronic Control System Diagnostics, OBD, Diagnostics
Fault Codes

Total: 30 Hours

Reference(s)

1. William.B.Ribbens , Understanding Automotive Electronics, 7th edition Butterworth-Heine publications,2012.
2. R.C Dorf and R.H. Bishop, Modern Control Systems, NJ: Prentice Hall, 2010
3. Robert Bosch Gmbh, Bosch Automotive Electric and Electronics, 5th edition Springer-Vieweg.2007
4. Tom Denton, Automobile Electrical and Electronic Systems, 3rd edition, Elsevier Butterworth-Heinemann 2004.
5. W.H.Crouse, Automobile Electrical Equipment, NY: McGraw-Hill Book Co Inc, 2005.
6. P.L.Kohli, Automotive Electrical Equipment, New Delhi: Tata McGraw-Hill Education co ltd, 2004.

21AU508 AUTOMOTIVE COMPONENTS MODELING LABORATORY

0 0 2 1

Course Objectives

- To impart knowledge on the optimization of design parameters for engine andchassis components.
- To educate with working knowledge on CAD software for the design and modelling ofengine and chassis components.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. An ability to design, analyze and find the solutions for automotive relatedproblems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Understand the concepts of automotive components designparameters.
2. Design the engine components using analytical calculation and model the same using CAD software.
3. Create the assembled model of engine as a functional system.
4. Design the chassis components using analytical calculation and model the same using CAD software.
5. Create the assembled model of chassis as a functional system.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3		3				2			3	3	3
2	3	2			3				2			2	3	3
3	3	3	3		3				2			3	3	3
4	3	2			3				2			2	3	3
5	3	3	3		3				2			3	3	3

1 **3 Hours**

EXPERIMENT 1
Design Piston, piston pin and piston rings and generate the part model of the same.

2 **3 Hours**

EXPERIMENT 2
Design small-end, shank, big-end and big-end bolts of a connecting rod and create the part model of the same.

3 **4 Hours**

EXPERIMENT 3
(i) Design the crank web and bearing of a center crank shaft and construct the part model of the same.
(ii) Assemble the part models of piston, connecting rod and crankshaft as a system.

4 **3 Hours**

EXPERIMENT 4
Design rocker arm, push rod and inlet and exhaust valves of a valve actuating mechanism and create the part model of the same.

5 **4 Hours**

EXPERIMENT 5
(i) Design cam lobe and shaft of a cam shaft and construct the part model of thesame.
(ii) Assemble the camshaft, rocker-arm, push rod and inlet/exhaust valve as a system.

6 **2 Hours**

EXPERIMENT 6
Design web, rim and ring gear of a flywheel and generate the part model of the same.

7 **2 Hours**

EXPERIMENT 7
Design disc, shaft, friction lining and springs of a single plate clutch and create the part model of the same.

8 **2 Hours**

EXPERIMENT 8
Assemble the flywheel and clutch as a system.

9 **3 Hours**

EXPERIMENT 9
Design spur gear and shaft of a gear box; create and assemble the part model of the same.

10 **4 Hours**

EXPERIMENT 10
Design the coil spring and strut of an independent suspension; construct and assemble the part model of the same.

Total: 30 Hours

Reference(s)

1. Paul Tran, SOLIDWORKS 2018 Intermediate Skills, SDC Publications.
2. Randy Shih, SOLIDWORKS 2018 and Engineering Graphics, SDC Publications.
3. Nader G. Zamani, Jonathan M. Weaver, CATIA V5 Tutorials: Mechanism Design &Animation ; Release 19, SDC Publications.
4. Richard Cozzens , CATIA V5 Workbook Release 19, SDC Publications.

21GE501 SOFT SKILLS - APTITUDE I 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

Course Outcomes (COs)

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyse the profit and loss of real time situations and the relation between ratio, proportionand variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoningproblems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2		2		3				
2						2		2		3				
3						2		2		2				
4						2		2		2				

1 **1 Hours**

NUMBER SYSTEMS

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility- Number of zeros in an expression.

2 **2 Hours**

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

3 **2 Hours**

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average-Replacement of some of the items.

4 **127 Hours**

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios-Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

5 **2 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

6 **3 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

7 **3 Hours**

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

8 **3 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

9 **3 Hours**

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

10 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

11 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

12 **3 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, McGraw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all CompetitiveExaminations, Revised Edition, Arihant Publications.

21HS002 PROFESSIONAL ETHICS IN ENGINEERING 2 0 0 2

Course Objectives

- To understand Human Values and ethical theory.
- To understand codes of ethics, work place responsibilities, rights, engineeringexperimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural ethics and engineers responsibility.

Programme Outcomes (POs)

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Articulate engineering ethics theory with sustained lifelong learning.
2. Adopt a good character and follow high professional ethical life.
3. Contribute to shape a better character by following ethical actions.
4. Confront and resolve moral issues occurred during technological activities.
5. Resolve moral and ethical problems through exploration and assessment byestablished experiments.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							2	3		3		2		
2							3	2		3		3		
3							2	3		2		2		
4							3	2		2		2		
5							2	3		3		2		

UNIT I **6 Hours**

HUMAN VALUES

Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others - Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy.

UNIT II **6 Hours**

ENGINEERING ETHICS AND PROFESSIONALISM

Scope of Engineering Ethics- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy - Kohlbergs and Gilligans theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance - justification - limitation - Abuse.

UNIT III **6 Hours**

ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as experimentation - Engineers as responsible experimenters - Balanced outlook on law - Cautious optimism - Safety and risk - Assessing and reducing risk - Safe exits - The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island andChernobyl.

UNIT IV **6 Hours**

WORKPLACE RESPONSIBILITIES AND RIGHTS

Fundamental Rights - Responsibilities and Duties of Indian Citizens - Teamwork - Ethical corporate climate - Collegiality and loyalty - Managing conflict - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights.

UNIT V **6 Hours**

GLOBAL ISSUES

Multinational corporations: Technology transfer and appropriate technology - International rights - promoting morally just measures - Environmental ethics: Engineering, ecology - economics - Human and sentient centred - and bio and eco centric ethics - Computer ethics and internet - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership.

FOR FURTHER READING

Sample code of ethics like IETE,ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

Total: 30 Hours

Reference(s)

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
3. R S Naagarazan, A text book on professional ethics and human values, New ageinternational (P)limited, New Delhi,2006.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics - Concepts and Cases, Wadsworth Thompson Learning, United States, 2005.
6. http://www.slideworld.org/slidestag.aspx/human-values-and- Professional-ethics

21AU602 DESIGN OF AUTOMOTIVE CHASSIS COMPONENTS

3 1 0 4

Course Objectives

- To obtain the clarity on design parameters of vehicle frame and steeringsystem.
- To choose appropriate joints for various types of loadings.
- To understand the principles involved in evaluating the shape and dimensions of an automotive chassis component to satisfy functional and strength requirements.
- To recognize the types of shafts and couplings used in power transmission.
- To distinguish the choice of spring for suspension system and clutch.
- To analyse the controlling factors of a brakingsystem.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Design vehicle frames and steering system components for various application.
2. Analyse the loading types for appropriate selection of joints.
3. Compute the design parameters of axles, shafts and couplings.
4. Choose appropriate spring and clutch for suspension systems and power transmission systems respectively.
5. Analyse the parameters of an automotive brakingsystem.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3												2	
2	3	3	3					3			3		3	
3	3	3	3					3			3		3	
4	3	3	3					3			3		3	
5	3	3	3					3			3		3	

UNIT I **9 Hours**

VEHICLE FRAME AND STEERING COMPONENTS

Loads acting on frames, chassis operating conditions, Determination of Centre of gravity, Design of frame for passenger and commercial vehicle - Design of straight and curved beams - "C" frame and crane hook. - Condition for true rolling, calculation of Ackermann linkage geometry, steering box design.

UNIT II **9 Hours**

DESIGN OF JOINTS

Design of bolted joints - stresses due to static loading, eccentrical loading. Design of welded joints - Butt and Fillet welded Joints-weld symbols, Strength of parallel and tranverse fillet welded Joints - Eccentrically loaded joints.

UNIT III **9 Hours**

DESIGN OF AXLES, SHAFTS AND COUPLINGS

Analysis of loads, moments and stresses at different sections of front axle, Design of front axle. Determination of bearing loads at Kingpin bearings, Design of propeller shaft based on strength, rigidity and critical speed - design details of final drive gearing, full-floating, semi-floating, three quarter floating rear axle and housings. Torsion bar. Design of rigid flange coupling and flexible coupling. Design of Cotter & Knuckle Joints.

UNIT IV **9 Hours**

DESIGN OF SPRINGS AND CLUTCUES

Spring Types, End connections, design parameters and spring materials. Design of helical springs - Circular and non-circular wire - Concentric springs. Design of leaf and torsional springs under constant and varying loads - Wahl"s stress factor. Types of friction clutches, Torque capacity of clutch, Design of single plate, multi-plate clutch, cone clutch and centrifugal clutch, Design of clutch components.

UNIT V **9 Hours**

DESIGN OF BRAKES

Brakes function, weight transfer during braking, stopping distance, brake torque analysis of Internal expanding shoe brake. Calculation of mean lining pressure and heat generation during braking, design of disc brake, mechanics of hydraulic braking system and parking brake.

Total: 60 Hours

Reference(s)

1. J.E. Shigley and C.R. Mischke, Mechanical Engineering Design, Tata McGraw - Hill Publishing Company Pvt. Ltd., New Delhi, 2017.
2. V.B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Education, 2017.
3. Khurmi. R.S. and Gupta. J.K., A Textbook of Machine Design, Eurasia Publishing House(Pvt) Ltd., 2005.
4. Lukin P, Gasparyants G, Rodionov V, Automobile Chassis Design and Calculations, MIR Publishers, Moscow 1989.
5. Giri, N.K., Automobile Mechanics, Khanna publishers, New Delhi, 2008.
6. http://www.nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Machine%20design1/New_index1.html

21AU603 VEHICLE BODY ENGINEERING 3 0 0 3

Course Objectives

- To acquire knowledge on types and construction of passenger and commercial vehicles body
- To understand the aerodynamics involved in vehicles
- To appreciate the mechanical design aspects related to vehicle bodyconstruction

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Illustrate the different types of car body.
2. Compare the commercial vehicle bodies and identify their types
3. Infer the parameters influencing the aerodynamics of the vehicle
4. Analyze the various loads acting on the vehiclebody.
5. Inspect the properties of materials used in vehicle body and explain the body painting and trimming processes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2													
2	2		2											
3	3	3	3		3								3	
4	3	3	3	3									3	
5	3	3	2		3								3	

UNIT I **9 Hours**

CAR BODY

Car body types-hatchback, saloon, convertibles, limousine, estate car, racing and sports car, Visibility - Regulations, driver"s visibility, tests for visibility, methods of improving visibility and space in cars, Safety-design and equipments-crumple zone, Car body construction - Design criteria and initial tests.

UNIT II **9 Hours**

COMMERCIAL AND PASSENGER VEHICLES

Commercial vehicle body technology- trends, special goods vehicle, Types of commercial vehicle body- flat platform, drop side, fixed side, tipper body, tanker body, Dimensions of driver"s seat relation to controls.

Buses and coaches- structural design, mini bus, single Decker, double-decker, two level and articulated bus.

UNIT III **9 Hours**

VEHICLE AERODYNAMICS

Vehicle drag - types, Types of forces and moments- effects of forces and moments, side wind effects on forces and moments, Body optimization techniques for minimum drag, Wind tunnel-Principle and types, Flow optimization techniques.

UNIT IV **9 Hours**

VEHICLE BODY LOADS

Idealized structure, structural surface, shear panel method, symmetric and asymmetric vertical loads in a car, longitudinal load, different loading situations, chassis frame design, Construction of Doors, door apertures, windows. Spare wheel carrier construction and design for different types of vehicle and weight distribution criteria in relation to Spare wheel location. Sources of body noises testing and methods of elimination. Water leakage test.

UNIT V **9 Hours**

BODY MATERIALS, TRIM AND MECHANISMS

Materials- steel sheet, timber, plastic, GRP, Properties of materials, Hand tools-power tools-panel repair-repairing sheet metal-repairing plastics-body fillers-passenger compartment service, Corrosion-anticorrosion methods, Selection of paint and painting process.

Total: 45 Hours

Reference(s)

1. L. Morello, L.R. Rossini, G. Pia and A. Tonoli, The Automotive Body, Volume I: Components Design, London: Springer, 2011.
2. D.A. Crolla, Ed, Automotive Engineering: Power Train, Chassis System and Vehicle Body, Oxford: Butterworth-Heinemann Elsevier Ltd, 2009.
3. J. Fenton, Handbook of Automotive Body Construction and Design Analysis, New Delhi:Wiley India, 2010.
4. P. L. Kohli,Automotive Chassis & Body, Papyrus Publishing House, New Delhi.2010
5. J Powloski, Vehicle Body Engineering, Business Books Ltd., London
6. J.G. Giles, Body Construction and Design, Vol. 6., llefe Books/Butterworth & Co. London

21AU607 VEHICLE MAINTENANCE LABORATORY 0 0 2 1

Course Objectives

- To acquire knowledge in vehicle servicing andtesting.
- To acquire skills in wheel alignment and wheel balancing.
- To acquire knowledge in valve grinding, valve lapping and cylinder re boring operations.
- To acquire skills in testing of spark plug and headlight.
- To acquire knowledge in A/C recovery and refilling in automobiles.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Demonstrate testing of two wheeler chassis dynamometer.
2. Explain the procedure for wheel alignment and wheel balancing.
3. Demonstrate valve grinding, valve lapping and cylinder re boring operations.
4. Explain the testing procedure for spark plug and headlight.
5. Explain the procedure for recovering and refilling of A/C in automobiles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1							1				1	
2	2	2							3				2	
3	2	1							2				1	
4	1	1							2				2	
5	1	1							1				1	

1 **3 Hours**

EXPERIMENT 1

Two wheeler chassis dynamometer testing

2 **4 Hours**

EXPERIMENT 2

Perform 3D wheel alignment for passenger vehicles

3 **4 Hours**

EXPERIMENT 3

Perform wheel balancing passenger and commercial vehicles.

4 **4 Hours**

EXPERIMENT 4
Tyre and wheel maintenance

5 **2 Hours**

EXPERIMENT 5
Perform valve grinding operation and valve lapping operation

6 **2 Hours**

EXPERIMENT 6
Perform 3D wheel alignment for commercial vehicles

7 **2 Hours**

EXPERIMENT 7
Perform cylinder re-boring operation

8 **2 Hours**

EXPERIMENT 8
Spark plug cleaning and gap adjustments

9 **3 Hours**

EXPERIMENT 9
Head light beam aligner

10 **4 Hours**

EXPERIMENT 10
Automotive A/C recovery and refilling

Total: 30 Hours

Reference(s)

1. P.M. Heldt, Automotive Chassis, New York : Chilton Co, 2014.
2. R.K. Rajput, A Text Book of Automobile Engineering, Delhi: Laxmi Publications Private Limited, 2007.
3. K. Singh, Automobile Engineering-Volume 1,Delhi: Standard Publishes Distributors, 2012.
4. N.K. Giri, Automotive Mechanics, New Delhi: Khanna Publishers, 2005.
5. T. Gilles, Automotive Chassis: Brakes, Suspension and Steering, New York: Thompson Delmar Learning, 2005.

21AU608 COMPUTER AIDED ANALYSIS LABORATORY

0 0 2 1

Course Objectives

- To provide procedural knowledge on modeling and meshing of machine components in finite element method package.
- To gain knowledge for finding stresses induced in structural, dynamic and thermal related applications using Finite Element Method Package.
- To impart knowledge on validation of dimensional specification of the product by verifying the values of stresses induced in the component.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Create geometry, descritize, apply boundary condition to solve problems of bars, truss, beams, plate to find stress with different loading conditions.
2. Identify the meshing elements, Boundary and load conditions for automotive components. Conditions by using Finite Element Method.
3. Structural Optimization of Automotive components for given Boundary and loadconditions.
4. Demonstrate the deflection of beams subjected to point, uniformly distributed and varyingloads further to use the available results to draw shear force and bending moment diagrams.
5. Analyze the structural and thermal Behavior for Automotive components use to solve the static and dynamics solver.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	3		2								1	
2	1	2	3		2								2	
3	1	3	2		3								2	
4	1	2	2		3								2	
5	1	3	3		2								3	

1 **2 Hours**

EXPERIMENT 1

Structural analysis of stepped bar to perform displacement and stress analysis using ANSYS APDL.

2 **3 Hours**

EXPERIMENT 2
Structural analysis of a simple and composite truss subjected to point loads to observe the deformation and axial stress distribution using ANSYS

3 **2 Hours**

EXPERIMENT 3
Structural analysis of beam elements subjected to point loads with UDL and UVL to observe deformation, shear force, bending moment and von misses stress distribution using ANSYS APDL.

4 **3 Hours**

EXPERIMENT 4
Structural analysis of solid element with drilled holes (steel plate and L bracket) subjected to point loads to observe deformation and von misses stress distribution using ANSYS APDL.

5 **2 Hours**

EXPERIMENT 5
Thermal analysis of composite cylinder subjected to conduction and convection to determine the heat transfer, Thermal flux and thermal gradient using ANSYS APDL.

6 **3 Hours**

EXPERIMENT 6
Static structural analysis of 3D bridge truss element to determine maximum deformation and stress by using ANSYS Workbench.

7 **3 Hours**

EXPERIMENT 7
Analysis of steady state temperature distribution in a three dimensional circular fin. To determine the heat transfer using ANSYS Workbench.

8 **4 Hours**

EXPERIMENT 8
Natural frequency and harmonic response of beam element using ANSYS Workbench.

9 **4 Hours**

EXPERIMENT 9
Static structural analysis of automobile components to determine deformation and stress using ANSYS Workbench.

10 **4 Hours**

EXPERIMENT 10
Thermal analysis of automobile components to determine steady state temperature distribution using ANSYS Workbench.

Total: 30 Hours

Reference(s)

1. S. S. Rao, Finite Element Method in Engineering, Elsevier India, 2005.
2. David V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2005.
3. Robert D. Cook, s. David ,Malkucs Michael E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley, New Delhi,2007.
4. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements Engineering, Pearson Education, New Delhi,2002
5. S. S. Bhavikati, Finite Element Analysis, New Age International Publishers, 2005

21GE601 SOFT SKILLS-APTITUDE II **0 0 2 0**

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

Course Outcomes (COs)

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sidescolored.
4. Interpret various data from graphs and tables to determine ratio, percentage andaverages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						3	2		2		3			
2						3	2		2		3			
3						2	3		3		2			
4						2	3		3		2			
5						3	2		2		3			

1 **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

2 **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

3 **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

4 **2 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

5 **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

6 **2 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

7 **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

8 **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

9 **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

10 **3 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

11 **3 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

12 **3 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

13 **3 Hours**

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solvingmethods-Puzzles.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, McGraw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for CompetitiveExaminations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all CompetitiveExaminations, Revised Edition, Arihant Publications.

21HS003 PRINCIPLES OF MANAGEMENT 2 0 0 2

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR relatedactivities.
- Learn the application of the theories in anorganization.
- Analyze the position of self and company goals towards business.

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Course Outcomes (COs)

Students will be able to

1. Understand the basic concepts ofManagement.
2. Have some basic knowledge on planning process and its Tools &Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2	3		2	2	2	2		
2						2	3		2	2	2	2		
3						2	2		2	2	3	3		
4						3	2		2	2	2	2		
5						2	3		3	3	3	2		

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management -Science or Art - Manager Vs Entrepreneur- types of managers - Managerial roles and skills - Evolution of Management - Scientific, Human Relations, System and Contingency approaches - Types of Business organization- Sole proprietorship, partnership, Company-public and private sector enterprises-Organization culture and Environment -Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning-Planning process-Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose - Formal and informal organization - Organization chart - Organization Structure and Types - Line and staff authority - Departmentalization - delegation of authority - Centralization and decentralization - Job Design-Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - types and theories of leadership - Communication - Process of communication - Barrier in communication - Effective communication - Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance - Direct and preventive control -Reporting.

Total: 45 Hours

Reference(s)

1. Robbins, S. (2017). Management, (13th ed.), Pearson Education, New Delhi.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals ofManagement, Pearson Education,7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007..
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGrawHill, 2008

21AU702 VEHICLE DYNAMICS 3 1 0 4

Course Objectives

- To acquire knowledge on road vehicle dynamics, stability and handling
- To develop an understanding of the relationships between vehicle design variables andvehicle dynamic behavior
- To apply modeling techniques to predict the dynamic behavior of road vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Apply laws of mechanics to calculate dynamic,road loads and equation motion.
2. Analyze gradeability, tractive force, barking force and stopping distance of avehicle.
3. Modeling the passenger car suspension of a vehicle.
4. Analyze the cornering and braking effort of a tire.
5. Apply steady state cornering model to design the steering system of avehicle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	1										3	
2	3	2	1										3	
3	2	3	3										3	
4	2	3	1										3	
5	2	3	1										3	

UNIT I **9 Hours**

INTRODUCTION

Vehicle and Earth fixed coordinate system, Euler angles, Dynamic axle loads - static loads on level ground - low speed acceleration, Loads on Grades. Road loads - rolling resistance - grade resistance. Equation of motion for Forced Undamped and forced Damped Vibration, Single DOF, Two DOF and Multi DOF systems.

UNIT II **9 Hours**

PERFORMANCE MODE

Acceleration - free body diagram of accelerating vehicle, maximum transferable tractive force and gradability. Deceleration - free body diagram of decelerating vehicle, maximum decelerating rates, stopping distance and maximum braking force. Prediction of Vehicle performance. Antilock Brake Systems, Traction control.

UNIT III **9 Hours**

RIDE MODE

Human response to vibration, Sources of Vibration. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-infinite and skyhook damping. Air suspension system and their properties.

UNIT IV **9 Hours**

TIRE DYNAMICS

Tire forces and moments, tire structure, longitudinal and lateral force at various slip angles, rolling resistance, tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire road friction. Test on various road surfaces. Tire vibration.

UNIT V **9 Hours**

HANDLING MODE

Vehicle control - low speed cornering and static steering - Steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), roll steer, compliance steer, ride steer, slip angle steer. Steady state handling - lateral acceleration gain, characteristic speed, yaw velocity gain and critical speed. Effect of braking on vehicle handling.

Total: 60 Hours

Reference(s)

1. H.Pacejka, Tire and Vehicle Dynamics, Oxford: Butterworth-Heinemann Elsevier Ltd, 2012.
2. R.N. Jazar, Vehicle Dynamics: Theory and Application, NY: Springer, 2017.
3. T.D. Gillespie, Fundamentals of Vehicle Dynamics, Michigan: SAE International, 1992.
4. J.Y. Wong, Theory of Ground Vehicles, John Willey & Sons, 2008.
5. D. Karnopp, Vehicle Dynamics, Stability and Control, Boca Raton: CRC Press, 2013.
6. https://nptel.ac.in/courses/107106080/

21AU703 INTELLIGENT VEHICLE SYSTEMS 3 0 2 4

Course Objectives

- To acquire knowledge on intelligent systems, focusing on those in-vehicle solutionsspecifically designed to improve driving and travelling energyefficiency
- To appreciate the role of electronics in providing improved control to a variety of vehiclesystems
- To enable evaluation of appropriate methodologies and be aware of the design and implementation issues of advanced techniques

Programme Outcomes (POs)

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Analyze the importance of modern trends in vehicle System
2. Apply the knowledge for selection of sensor and communication protocols for interfacingsensors
3. Apply the knowledge for understanding the traffic information in thesurroundings
4. Compare the various intelligent systems used in automobiles and entertainment features inside the vehicle
5. Explain the intelligent systems associated with Autonomous vehicle

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1			2		3		2							2
2			1		2		1							1
3			3		1		2							1
4			2		1		3							2
5			1		2		2							2

UNIT I **7 Hours**

INTRODUCTION TO INTELLIGENT VEHICLE SYSTEMS

Definition, modern trends in Auto industry, various intelligent systems present in the vehicle, Need for IVS, Benefits, Advanced Driver Assistance System-Types/Levels, Next Generation Intelligent Vehicles, General Vehicle Control.

UNIT II **10 Hours**

IOT IN AUTOMOBILES

Developments on IoT in Automotive Sector, Connected Car Services and Applications- Infotainment, Vehicle and Smartphone Integration, Driving Insights- Analytics, On Board Diagnostics, Real Time Driver Monitor, Geo fencing and Speed Monitoring, Stolen Vehicle Tracking, Biometrics Information for

Driver Identification, Vehicle Communication- V2V, V2X, V2R, IoT in Intelligent Transportation , Introduction to Autonomous Vehicle.

UNIT III **10 Hours**

TRAFFIC SURROUNDINGS

Modelling traffic and driver interactions, Simulation of driver and city interaction, Behavior and driving pattern, simulation of driver and highway interaction, Behavior and driving pattern, Application: Traffic alert - Real time road data on Navigation, Navigation System- Global Positioning System, Geographical Information Systems Architecture, Road Sign Recognition.

UNIT IV **9 Hours**

CONNECTED VEHICLE SYSTEMS

Introduction to CVS, Telematics control system architecture -driver information systems, Vehicle - vehicle interaction using TCS, Current trends in auto industry, In-Vehicle Entertainment System - Mirror link, Web link, App link, Apple Car Play, Android Auto. Application: ecall system - design, functions and limitations.

UNIT V **9 Hours**

AUTONOMOUS VEHICLE COMFORT SYSTEMS AND APPLICATIONS

Introduction- Design overview, circuit diagram and Algorithm, Driver safety systems- ABS, Driver Aid system- ESP, Blind Spot monitoring system, Collision mitigation system, Adaptive Headlamps, Automatic parking system, Eight way seating system, Adaptive cruise control system, Collapsible and tiltable steering column, Lane Departure Warning.

1 **3 Hours**

EXPERIMENT 1

Observe and implement the Lane Departure Warning system

2 **3 Hours**

EXPERIMENT 2

Experiment the Seat Belt Pretension with crash sensor

3 **3 Hours**

EXPERIMENT 3

Detecting faults using On Board Diagnostics

4 **3 Hours**

EXPERIMENT 4

Implementation of Driver Monitoring system

5 **3 Hours**

EXPERIMENT 5

Stolen Vehicle Tracking using GPS and GSM modem

6 **3 Hours**

EXPERIMENT 6

Road Sign Recognition using image processing

7 **3 Hours**

EXPERIMENT 7
Design and construction of Fleet management using Telematics

8 **3 Hours**

EXPERIMENT 8
Study and implementation of V2V system

9 **3 Hours**

EXPERIMENT 9
Design and implementation of Adaptive Cruise Control system

10 **3 Hours**

EXPERIMENT 10
Design and construction of Adaptive Headlamp system.

Total: 75 Hours

Reference(s)

1. A. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.
2. A. Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer-Verlag London Ltd, 2012.
3. R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014.
4. H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.
5. P. C. Cacciabue (Ed.), Modelling Driver Behavior in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems, Springer-Verlag London Ltd, 2007.

21AU707 VEHICLE DYNAMICS LABORATORY 0 0 2 1

Course Objectives

- To gain knowledge on the dynamics of the power train, brakes, steering, suspension and wheel and tire subsystems and their interactions
- To provide practical knowledge on modeling and simulation of vehiclesystems
- To develop skills in evaluation of parameters that effect vehicle performance relative to drive-off, braking, directional control and rollover

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Identify important vehicle system parameters useful for effective application of vehicledynamics
2. Analyze the suspension, braking and steering system parameters in roadcondition
3. Analyze the car body and trailer parameters in different conditions
4. Analyze the modeled vehicle in different conditions by various maneuvers
5. Analyze the vehicle models with advanced driver assistancesystems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2			3								2	
2	1	2	2		3								2	
3	1	2			3								3	
4	1	2			3								2	
5	1	2			3								2	

1 **2 Hours**

EXPERIMENT 1

Study on automotive systems simulation

2 **4 Hours**

EXPERIMENT 2

Simulation and analysis of rigid axle suspension system

3 **2 Hours**

EXPERIMENT 3
Simulation and analysis of independent suspension system

4 **4 Hours**

EXPERIMENT 4
Simulation and analysis of hydraulic brake system

5 **2 Hours**

EXPERIMENT 5
Simulation and analysis of air brake system

6 **2 Hours**

EXPERIMENT 6
Simulation of steady state cornering characteristics of vehicle

7 **4 Hours**

EXPERIMENT 7
Modeling of tires and analysis of cornering characteristics

8 **4 Hours**

EXPERIMENT 8
Roll stability and Rollover threshold analysis

9 **4 Hours**

EXPERIMENT 9
Simulation of a half car model for pitch and bounce

10 **2 Hours**

EXPERIMENT 10
Crash test simulation analysis of a four wheeler

Total: 30 Hours

Reference(s)

1. H.Pacejka, Tire and Vehicle Dynamics, Oxford: Butterworth-Heinemann Elsevier Ltd, 2012.
2. R.N. Jazar, Vehicle Dynamics: Theory and Application, NY: Springer, 2017.
3. T.D. Gillespie, Fundamentals of Vehicle Dynamics, Michigan: SAE International, 1992.
4. J.Y. Wong, Theory of Ground Vehicles, John Willey & Sons, 2008.
5. D. Karnopp, Vehicle Dynamics, Stability and Control, Boca Raton: CRC Press, 2013.
6. https://nptel.ac.in/courses/107106080/

21AU708 PROJECT WORK I **0 0 6 3**

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standardprocedures.
- To teach use of new tools, algorithms and techniques required to carry out theprojects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the designsolutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of theproject.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare technical report and oralpresentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3	2			2	1							
2	2	2	1	3		2					2	2		
3			3	2	2			2			2	2		
4		1		2	3	1	2	2						
5									3	3		2		

21AU804 PROJECT WORK II **0 0 18 9**

Course Objectives

- To develop skills to formulate a technicalproject.
- To develop skills to formulate a technicalproject.
- To teach use of new tools, algorithms and techniques required to carry out theprojects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to oneÃ¢??s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the designsolutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of theproject.
4. Test and validate through conformance of the developed prototype and analysis thecost effectiveness.
5. Prepare technical report and oral presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		3	2			2	1							
2	2	2	1	3		2					2	2		
3			3	2	2			2			2	2		
4		1		2	3	1	2	2						
5									3	3		2		

18HS201 COMMUNICATIVE ENGLISH II **1 0 2 2**

Course Objectives

- Read and understand ideas of complex text on both concrete and abstracttopics
- Listen and understand technical discussions in his/her field of specialisation
- Produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Use appropriate grammar and vocabulary that is expected at the BEC Vantage examlevel.
2. Understand the general meaning of non-routine letters, and of a report of predictable / unpredictable topic
3. Write simple reports of factual nature and factual non-routineletters
4. Ask for factual information and understand the answer; and take/pass on workplacemessages
5. Express opinions and present arguments to a limited extent; and give simple, prepared presentations on familiar topics

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1														
2									2					
3									3					
4										1				
5										2				

UNIT I **9 Hours**

GRAMMAR3

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

UNIT II **9 Hours**

READING

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

UNIT III **9 Hours**

WRITING

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

UNIT IV **9 Hours**

LISTENING

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

UNIT V **9 Hours**

SPEAKING

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision- aking. 1.A Horse and Two Goats - R K Narayan 2.My Lord the Baby - Rabindranath Tagore 3.Twist in the Tale - Jeffery Archer.4.The Third and Final Continent - Jhumpa Lahiri

5. The Gift of the Magi - O Henry

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage- Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

18HSC01 CHINESE **1 0 2 2**

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. listen and identify individual sounds of Chinese
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2				
2										2				
3										3				
4										2				
5										3				

UNIT I **9 Hours**

Hello | 1.Initials and Finals of Chinese | b,p,m,f,d,,n,l,g,k,h,j,q,x | 2. Tones Four | 3.Chinese Syllables | 4.Tone S

UNIT II **9 Hours**

Thank you | Initials and Finals of Chinese | The Neutral Tone | Rules of Tone Marking and Abbreviation

UNIT III **9 Hours**

1. What""s your name - In the school; -In the classroom; -In the school | The Interrogative Pronoun | 2 The Sentence | 3 Interrogative Sentences with

UNIT IV **9 Hours**

She is my Chinese teacher | In the library | The Interrogative Pronouns | The Structural Particle | The interrogative Particle

UNIT V **9 Hours**

Her daughter is 20 years old this year | 1.The Interrogative Pronoun | 2. Numbers below 100 | 3.Indicating a Change | The Interrogative Phrase

Total: 45 Hours

18HSF01 FRENCH **1 0 2 2**

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-dayscenarios

Programme Outcomes (POs)

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. To help students acquire familiarity in the French alphabet & basicvocabulary
2. listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing languagetasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2				
2										2				
3										3				
4										2				
5										3				

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue francaise, alphabets, les numeros, les jours, les mois. Grammaire Les verbes s"appeler,etre, avoir, les articles definis, indefinis Communication - Saluer, s"informer sur quelquun, demander de se presenter Lexique - Les alphabets, les nationalites, age, les pays, les couleurs, les jours de la semaine, les mois de l"annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites Grammaire - Verbes - Conjugaison : Present (Avoir / etre / ER, IR, RE : Regulier et Irregulier) - Adjectifs les propositions de lieu Communication - Chercher un logement, d"ecrire son voisin, s"informer sur un logement Lexique - L"habitat, les pieces, l"equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN

Grammaire - Articles contractes, verbes vouloir, pouvoir, devoir, adjective interrogative, future proche
Communication- Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie
Lexique - le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT Ãƒ???Ãƒ??Ãƒ?Ã‚Â?? SÃƒ???Ãƒ??Ãƒ?Ã‚Â??OUVRIR Ãƒ????Ãƒ???Ãƒ??Ãƒ?Ã‚Â LA CULTURE

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, l"imparfait
Communication - Propose aÃƒ?Ã‚Â quelqu""un de faire quelque chose, raconteur une sortie au passe parler un film
Lexique - Les sorties, la famille, art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite
Communication Accepter et refuse rune invitation, donner des instructions, commander au restaurant
Lexique Les services et les commerces, les aliments, les ustensiles, argent

Total: 45 Hours

Reference(s)

1. Saison A1, Methode de francais
2. Hachette FLE

18HSG01 GERMAN **1 0 2 2**

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German inday-to-dayscenarios

Programme Outcomes (POs)

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. listen and identify individual sounds of German
2. use basic sounds and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand and use basic grammar and appropriate vocabulary in completing languagetasks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2				
2										2				
3										3				
4										2				
5										3				

UNIT I **9 Hours**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

UNIT II **9 Hours**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

UNIT III **9 Hours**

Regular & Irregular verbs - Personal pronouns - family - Introduction to types of sentences

UNIT IV **9 Hours**

Question words-Types of Questions - Nominative case- Verb Conjugation - country - nationalities

UNIT V **9 Hours**

Verbs - to be & to have - conjugation - Hobbys - Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015
2. Langenscheidt Eurodictionary - German - English / English - German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

18HSH01 HINDI **1 0 2 2**

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simpleday-to-daysituations
- To help students acquire the ability to understand a simple technical text in Hindi

Programme Outcomes (POs)

Course Outcomes (COs)

1. Construct simple sentences and use vocabulary required for day-to-dayconversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Appear for Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1														
2														
3														

UNIT I **9 Hours**

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II **9 Hours**

Nouns: Genders (Masculine & Feminine Nouns long vowels and short vowels - -Masculine & Feminine - Reading Exercises.

UNIT III **9 Hours**

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

Classified Vocabulary: Parts of body - Relatives - Spices - Eatables - Fruit & Vegetables - Clothes - Directions - Seasons - Professions.

UNIT V **9 Hours**

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. Hindi Prachar Vahini-1 by Dakshin Bharat Hindi Prachar Sabha Chennai
2. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People,Vee Kumar Publications(P)Ltd., New Delhi,2009
3. Videos, Stories, Rhymes and Songs

18HSJ01 JAPANESE **1 0 2 2**

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquettes

Programme Outcomes (POs)

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Recognise and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2				
2										2				
3										2				
4										2				
5										2				

UNIT I **9 Hours**

Introduction to Japanese - Japanese script- Pronunciation of Japanese(Hiragana)- (Katakana) Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. N1 wa N2 desu - N1 wa N2 ja arimasen - S ka N1 mo - N1 no N2 - san - Kore - Sore - Are - Kono N - Sono N - Ano N - Sou desu - Sou ja Arimasen - S1 ka - S2 ka - N1 no N2 - Sou desu ka - Koko - Soko - Asoko - Kochira - Sochira Achira - N1 wa N2 (place) desu - Doko - Dochira - N1 no N2 - Ko - So - A - Do (Demonstrative words) - O kuni Kanji10 - Technical Japanese Vocabulary (30 Numbers)

UNIT II **9 Hours**

Introduction to time - Ji - Fun - Pun - Introduction of verbs - V Masu - V Masen - V Mashita - V Masendeshita N (Time) Ni V - N1 Kara - N2 Made - N1 to N2 - S Ne - N (Place) e Ikimasu - Kimasu - Kaerimasu - Doko (e) Mo Ikimasen - Ikimasendeshita - N (Vechile) de Ikimasu - Kimasu - Kaerimasu - N (Person / Animal) to V - Itsu - S Yo N o (transitive) - N o Shimasu - Nani o Shimasuka - Nan and Nani - N (place) de V - V Masenka - V Mashou - o - Kanji 10 - Technical Japanese Vocabulary (30 Numbers) .

UNIT III **9 Hours**

N (tool/means) de V - Word/Sentence wa Go de Nani desu ka - N (person) Ni Agemasu, etc - N (person) Ni Moraimasu etc - Mou V Mashita - Introduction to Adjectives - N wa Na adj (Na) desu - N wa II adj (II) desu - Na adj Na n - II adj (II) N - Totemo - Amari - N wa Dou desuka - N1 wa Donna N2 desuka - S1 Ga S2 - Dore N ga Arimasu - Wakarimasu - N Ga Sukidesu - Kiraidesu - Jozu desu - Heta desu - Donna N - Yoku - Daitai - Takusan - Sukoshi - Amari - Zenzen - S1 kara S2 - Doushite - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

UNIT IV **9 Hours**

N ga Arimasu - Imasu - N1 (place) Ni N2 ga Arimasu - Imasu - N1 (thing/person/place) no N2 (position) - N1 ya N2 - Word (s) desuka - Chirisosu wa Arimasuka - Saying numbers - Quantifier (period) Ni kai V - Quantifier Dake - N dake - Past tense of Noun sentences and Na adjective sentences - Past tense of ii adjective sentences - N1 wa N2 yori adjective desu - N1 to N2 to dochira ga adjective desu ka - N1/N2 no houga adjective desu - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

UNIT V **9 Hours**

N ga hoshi desu - V masu form tai desu - N (place) e V masu form - N Ni - ikimasu - kimasu - kaerimasu N ni V - N o V - dou ko ka - nani ka - go chuu mon - Verb conjugation - Verb groups - Verb te form - V te form kudasai - V te form imasu - V masu from mashouka - S1 ga S2 - N ga V - V te form mo ii desu - V te form wa ikemasen - V te form imasu Shrimasen - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

Total: 45 Hours

Text Book(s)

1. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

Reference(s)

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

18AU0XA PLASTICS-DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING

1 0 0 1

Course Objectives

- To know the various plastic materials used in Automotive, home appliance and Medicalfields.
- To understand the basic and advanced methods of plastic processing and the tooling and equipment used for it.
- To learn various post processing requirements such as painting, foiling and padpainting.
- To learn the various plastic joining processes and plastic testing methods.

Programme Outcomes (POs)

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. An ability to design, analyze and find the solutions for automotive relatedproblems

Course Outcomes (COs)

1. Understand the plastic material types and its applications.
2. Summarize the plastic processing methods, machine and tooling used forit.
3. Classify the post processing requirements and their importance
4. Understand the plastic joining processes like USW, VW, Etc.,
5. Understand plastic testing methods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2						2		
2						2						3	2	
3						2						3		
4												2		
5				2		2						2	2	

UNIT I **15 Hours**

PLASTICS - DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING

Introduction on plastics, Types of plastics - Thermo plastics, Thermo setting plastics, Applications in Automobiles, Home appliances etc., Basic concepts on plastics design, Mould flow analysis, Plastic processing - Preheating, Molding, Molding types - Injection molding, compression molding, Rot molding, 2K molding, Tooling - Core, cavity, inserts, Heating and cooling circuits, Tool materials, Molding machines - Types, tonnage and other specifications. Molding defects - Warpage, Catching, Weld line, burning, Sink marks etc., Method of avoiding defects, Post molding process - Annealing, Texturing, color foiling, pad painting, Painting, etc., Assembly of plastics - Ultrasonic welding, Heat sinking, Vibration welding. Testing of plastics - UV Testing, Scratch resistance, Flammability, resistance against chemicals, impact test.

Total: 15 Hours

Reference(s)

1. Charles A Harper, Hand book of plastic technologies
2. Crawford R.J, Plastic engineering
3. Charles A Harper and Edward M petrie, Plastic materials and Processes - A conciseEncyclopedia

18AU0XB VEHICLE TESTING AND CERTIFICATION 1 0 0 1

Course Objectives

- To impart knowledge on motor vehicles emission inspections to determine compliance with established emissions standards
- To develop knowledge required for validation of vehicle components and systems

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. An ability to design, analyze and find the solutions for automotive relatedproblems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Compare the emission norms of different Categories of Vehicle
2. Expalin the procedure for vehicletesting

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	2	3							2	2	
2	1		1	2	2							2	3	2

UNIT I **4 Hours**

HOMOLOGATION, CERTIFICATION

Introduction about Homologation, India Automotive Industry, Vehicle Category (UNECE), Overview of Vehicle type & approval, Environmental Regulation, Decade of Road Safety.

UNIT II **8 Hours**

EMISSION REGULATION, TESTING METHODS

Emission Norms for Different Categories of Vehicle and Engines, Idling CO and HC Test, Free Acceleration Test, Crankcase & Evaporative test, Type Approval of Instruments for checking the emission from in service vehicles.

UNIT III **8 Hours**

VEHICLE TESTING

Durability Testing -Types , Procedures & Measurements Methods, Components validation -Types , Procedures & Measurements Methods, Testing Measurement Instruments - Types ,Procedures & Measurements Methods, Vehicle Calibration & Testing -Types , Procedures & Measurements Methods.

Total: 20 Hours

18AU0XC AUTOMOBILE EMBEDDED SYSTEM 1 0 0 1

Course Objectives

- To provide students the skills required to interface devices and build a complete systems of automobiles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. An ability to design, analyze and find the solutions for automotive relatedproblems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Explain automotive Embedded Systems and their Features
2. Compare the function of varies brake control module

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2		2							2	2	2
2	2	1	2		3							2		3

UNIT I **4 Hours**

INTRODUCTION TO AE

Automotive Embedded Systems and their Features, Classification of Automotive Embedded Systems, Example Systems-Engine Management, Evolution Steps of Automotive Control Systems, Current Problems of Automotive Embedded Systems, Platform-base Development, AUTOSAR, JASPAR, ISO 26262-Functional Safety Standard

UNIT II **4 Hours**

ROLE OF ECUS IN AE

Door control unit, Engine control unit, Electric Power Steering Control Unit, Human-machine interface (HMI), Power train control module (PCM):Seat Control Unit, Speed control unit, Telematic control unit, Transmission control unit, Brake Control Module (BCM; ABS or ESC), Battery management system

UNIT III **4 Hours**

HOW AN ECU IS BUILD

PCB manufacturing process, Component selection & norms, Housing/Enclosure of ECUs

UNIT IV **4 Hours**

DIAGNOSTICS AND ITS TYPES

Importance of CAN, Standard interfaces, OBD-II signal protocols, OBD applications, Hands on experience of Onboard diagnostics

UNIT V **4 Hours**

OS(OPERATING SYSTEM/ OPEN SOURCE)

Types of RTOS,Open Source RTOS,Free RTOS,OSEK standards, AUTOSAR OS

Total: 20 Hours

18AU0XD GASOLINE INJECTION SYSTEMS 1 0 0 1

Course Objectives

- To provide knowledge on recent developments in gasoline injection systems which includes direction injection for SI engines

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Compare the function of different SI Engine injectionsystems
2. Analyze the importance of ECU in Engine Managementsystems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	2	1							2		2
2	2		2		3							2		2

UNIT I **5 Hours**

GASOLINE INJECTION SYSTEM

Introduction to SI engine management systems, Different Injection systems employed in SI system, Group and Sequential injection techniques, GDI techniques an overview.

UNIT II **5 Hours**

GASOLINE DIRECT INJECTION SYSTEM

GDI techniques to control Fuel Injection, Ignition control methodologies, Lambda control, idle speed control, Adaptive knock control, Combustion and Torque estimation.

UNIT III **5 Hours**

OVERVIEW OF ECU ON EMS AND TYPE OF GDI INJECTORS

Introduction to Engine control units for GDI systems, Role of sensors and actuators in Injection systems, different kind of Injectors used in GDI systems, Performance (Speed, Power, and Torque), Control (Emission, Fuel Economy, Drivability and Safety) & Legislation (Environmental legislation for pollution and safety Norms).

Total: 15 Hours

18AU0XE ADVANCED MOTOR SPORTS ENGINEERING

1 0 0 1

Course Objectives

- To provide students with a sound understanding of the fundamental scientific, engineering and design principles involved in motorsport, and their implementation within a high performance technology context

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information toprovide validconclusions.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technologicalchange.
m. An ability to design, analyze and find the solutions for automotive relatedproblems

Course Outcomes (COs)

1. Design of intake and exhaust system for SI engine
2. select appropriate air fuel ratio & spark timings for racing engine

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2									2	2	
2	2		2	1								2		

UNIT I **5 Hours**

INTRODUCTION TO MOTORSPORTS ENGINEERING

History of motorsports.A brief look at the events, SAE Events-Baja SAE, SAE Supra.

UNIT II **15 Hours**

RACING VEHICLE DESIGN

Design of intake & Exhaust system-design of runner length & diameter & plenum volume, ram theory, high performance exhaust configuration 4-1 & 4-2-1 configuration etc. Design & modification of high performance Engine for Racing-selection of compression ratio, high performance cam shaft , Calibration & Testing of racing vehicles in Engine chassis dynamometer-selection of appropriate air fuel ratio & spark timings for racing engine. Data Logging & Analysis-Real time data logging in race track and analysis.

Total: 20 Hours

18AU0XF AUTOMOTIVE PRODUCT DEVELOPMENT 1 0 0 1

Course Objectives

- To provide knowledge on recent developments in product development in automotive field.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
f. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
g. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.
h. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

3. Compare the function of different SI Engine injectionsystems
4. Analyze the importance of ECU in Engine Managementsystems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	2	1							2		2
2	2		2		3							2		2

UNIT I **5 Hours**

INTRODUCTION

Introduction, Overview of mechanical product development process, Workflow in product development and functions / departments, Systems engineering of vehicle, Internal and external complexity, Concurrent engineering, Product development funnel.

UNIT II **5 Hours**

PRODUCT PLANNING AND CONCEPT DEVELOPMENT

Product planning, Concept development, Automotive design and aerodynamics, Points on automotive design, Ergonomics, Ergonomics analyses and seating buck, Vehicle specification.

UNIT III **5 Hours**

VEHICLE ARCHITECTURE AND SYSTEM DESIGN

Vehicle architecture, Powertrain arrangement, Middle engine arrangement, Vehicle constructin, Suspension configuration, selection and Modular platforms, Powertrain development process.

Total: 15 Hours

18AU0XG AUTOMOTIVE INTERIOR COMPONENTS DEVELOPMENT 1 0 0 1

Course Objectives

- To provide knowledge on recent developments in interior components design.
- To provide the knowledge on CATIA modeling and drafting.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Understand the Interior and Exterior trim design requirements.
2. Apply CATIA tool to model the interior components design.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	2	1							2		2
2	2		2		3							2		2

UNIT I **5 Hours**

AUTOMOTIVE TRIM DESIGN

Automotive Product development-Introduction, Automotive sketching, clay modeling, Industrial Engineering Drawing, Introdruction about Interior and exterior trims - styling and master section, Injection moulding concepts, Product Design Considerations, Real time Part showing and detailing, Introduction about CATIA - CATIA Part modeling and drafting, Project work flow.

Total: 15 Hours

18AU0XH CONNECTED VEHICLES 1 0 0 1

Course Objectives

- To provide knowledge on recent developments in Mobility Engineering this includes Connected Vehicles.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide validconclusions.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Compare the function of different Automotive Communication Networks, Sensors.
2. Analyze the importance of Connected Vehicle Applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	2	1							2		2
2	2		2		3							2		2

UNIT I **5 Hours**

AUTOMOTIVE SENSORS

Automotive Sensors - Types, Engine and Vehicle Sensors – Characteristics and Parameters, Environmental Sensors – Characteristics and Parameters.

UNIT II **5 Hours**

AUTOMOTIVE COMMUNICATION NETWORKS AND DATA ACQUISTION ANALYSIS

Different Types of Automotive Communication Networks, CAN, LIN, J1939, Gateways and Controllers, Different Layers in Networks, Data acquisition Methods , OBD Protocols, Data Analysis. Fuzzy logic and its control techniques.

UNIT III **5 Hours**

CONNECTED VEHICLE APPLICATIONS

Telematic systems, Vehicle Tracking systems, Machine Fault Diagnosis ,Usage based Insurance, Network Optimisation ,Vehicle to Vehicle, Vehicle to Radar, Vehicle to Satellite communication systems.

UNIT IV **5 Hours**

CYBER SECURITY DATA SECURITY AND PIRACY

Threat Matrix in Vehicle systems, Vulnerability of current Autonomous systems, Data security in connected Vehicle applications, Legal aspects of Connected Vehicle systems, privacy and security aspects in Connected Vehicles.

Total: 20 Hours

18AU0XI MODEL-BASED SYSTEM DESIGN 1 0 0 1

Course Objectives

- To know the various Model-Based System Design process.
- To understand the Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), and Hardware-in-the-Loop (HIL) concepts.
- To learn about various Real-Time Simulation concepts.

Programme Outcomes (POs)

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
l. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Build mathematical models for components in a system.
2. Follow a process of continuous refinement and improvement to generate accurate models.
3. Connect component models together to model a larger more complex system.
4. Set up and run Model-in-the-Loop Simulations (MIL).
5. Set up and run real-time simulations for a physical system.
6. Set up and run Hardware-in-the-Loop Simulations (HIL).

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1				2		2						2		
2				2		2						3	2	
3				2		2						3		
4				2								2		
5				2		2						2	2	

UNIT I **5 Hours**

INTRODUCTION TO MODEL-BASED SYSTEM DESIGN

Introduction to Systems Engineering, Systems Engineering and the Life Cycle, Systems Engineering Process Overview, Business Impacts of Systems Engineering, Motor Model, Generator Model, Controller Model, SimDriveline Introduction.

UNIT II **10 Hours**

REAL-TIME SIMULATIONS

Processor In The Loop Real-Time Simulations, Controller on Freescale Target, Plant on Real-Time Target, Data Collection of Performance.
Model-in-the-Loop (MIL), Software-in-The-Loop Simulations (SIL), Hardware-in-the-Loop (HIL).
Introduction to Simulink Simulations- Implement controller Explore the system response using different control methods, Tune the system, explore system limitations, Understand and refine motor models.

UNIT III **5 Hours**

MODEL REFINEMENT AND RE-VERIFICATION

Compliance Adjustment of models, Comparison of observed and simulated behaviours, Update Models to Include Measured Data, Comparison of Updated Physical Plant to Model.

Total: 20 Hours

Reference(s)

1. Practical Model-Based Systems Engineering, by Jose L. Fernandez, Carl Hernandez.
2. Effective Model-Based Systems Engineering, John M. Borky, 2018
3. Model-Based Systems Engineering, A. Wayne Wymore, CRC Press; 1st edition (April 5, 1993),
4. Model Based Systems Engineering: Fundamentals and Methods, Patrice Micouin, Wiley.
5. **https://in.mathworks.com/**

18AU0XJ VEHICLE DYNAMICS FOR EV 1 0 0 1

Course Objectives

- To predict, respond and behavior of vehicles under different driving conditions.
- To Define Mathematical model for the electric vehicle
- To simulate the model of a DC motor and electric bike using MATLAB.

Course Outcomes (s)

1. To analyse the vehicle steady state handling behaviour of EV using MATLAB
2. To design a simulation model of vehicle dynamics using MATLAB for electric vehicle

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2		2		2							2		2
2	2		2		2							2		2

Introduction – Derive the mathematical model of the vehicle – simulation model of vehicle with MATLAB:Develop the dynamic model of the vehicle with MATLAB, speed torque-characteristics of the vehicle ,store the characteristics in the lookup table.-System level modelling for two-wheeler, System level modelling of four-wheeler, Battery modelling, Battery Management System,mathematical model of DC motor, simulation model of DC motor- passive loading scheme – validation.

Total: 15 Hours

Project: Motor and Battery Modelling of Electric Vehicle using Simulink
Project: Speed torque characteristics of Electric Vehicle using MATLAB.

Reference(s)

1. https://in.mathworks.com/help/autoblks/powertrain-reference-applications.html
2. Vehicle Dynamics, Theory and Application, Reza N. Jazar, Springer, 2009, ISBN 978-0-387-74243-4, eISBN 978-0-387-74244-1.

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18AU0XK ELECTRONIC SYSTEM THERMAL MANAGEMENT 1 0 0 1

Course Objectives

- To emphasize the importance of thermal and fluid science aspects in electronic devices.
- To empower graduates towards design of active and passive thermal management devices.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Course Outcomes (COs)

1. Address the challenges of governing thermal control on the silicon elements.
2. Analyse the root causes for heat generation and adopt trending methods to control the electronics heating.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2		2								2	2	
2	2	2	2		2								2	2	

UNIT I **5 Hours**

Electronics Heating and Cooling.

Introduction– importance of thermal management of electronics, temperature effects on different failure modes, Power transistors, Power diodes, Central processing units (CPUs) Causes of heat generation in electronic systems, Effects of excessive joint temperature, Need for cooling of electronic components. Thermal cooling options: air and liquid, Cooling methods used in the industry for electronics–conduction cooling, cooling by heat sink, liquid immersion cooling, flow-through cooling of CCAs, cold- wall cooling, cold plates, jet impingement cooling, synthetic jet cooling, thermoelectric or solid state coolers, Trends in selection of cooling media and arrangements. Application of extended surfaces: external fins, heat sinks, Trends in heat sink technology, Forced draught, Fan sizing procedure and fan selection guidelines, Fans working in series and in parallel.

UNIT II **10 Hours**

Thermal Management

Heat transfer compounds, thermally conductive pastes, Epoxy resins, Liquid cooling of electronic devices, Liquid coolants and alternative liquid coolants for high density electronics, Evaporation and Condensation. Thermoelectric cooling: Thermoelectric cooling principles (TEC), Applications in electronics systems, Peltier effect of cooling and semi-conductors, Selection of cooling technique– ranges of cooling rates of different cooling methods, selection criteria; Experimental techniques used for thermal measurements; Reliability issues: importance, bathtub curve. Practical session- Electronic Thermal audit and thermal control.

Project: Ability to write a model technology transfer/ translational document procedure.

Total: 15 Hours

Reference(s)

1. Fluid Flow, Heat Transfer and Boiling in Micro-Channels by L.P. Yarin, A. Mosyak and G. Hetsroni, 2009 Springer-Verlag Berlin Heidelberg ISBN 978-3-540-78754-9 and eISBN 978-3-540-78755-6.
2. The CRC Handbook of Thermal Engineering, by Frank Kreith Springer, ISBN: 3-540-66349-5.

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18AU0XL DESIGN AND SELECTION OF HVAC SYSTEM

1 0 0 1

Course Objectives

- To understand the basics of HVAC and its practical applications
- To understand the proper way to do the calculations
- To understand the selection of AC's

Course Outcomes (s)

1. Classify the standards and fundamentals of Heat load calculations.
2. Design and selection of HVAC systems using analytical tools.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2		2								2	2	
2	2	2	2		2								2	2	

Introduction to HVAC – VCR System– Selection of compressor, capillary and Heat exchanger- Selection of Cold storage based on cooling load,- Heat Load calculation as per ASHRAE – 55 –U factor calculation for various construction materials- Psychrometric properties and Process - Thermal comfort chart, Types of AC, Standard capacity, Selection of AC's for domestic and commercial application.

Total: 15 Hours

Reference(s)

1. W. Larsen Angel , HVAC Design Sourcebook, Tata McGrawhill, Second Edition, 2020
2. Roger Haines, Lewis Wilson, HVAC Systems Design Handbook, McGraw-Hill Education, 5th edition, 2009
3. Herbert W. Stanford III, HVAC Water Chillers and Cooling Towers: Fundamentals, Application, and Operation, CRC Press, Second Edition, 2017
4. Robert McDowall, Fundamentals of HVAC Systems, Elsevier Science, CBS Publishers and Distributors pvt Ltd, Second Edition, 2006
5. Mohsen Sheikholeslami Kandelousi, HVAC System. Intechopen, 2018
6. Design Guide for Heating, Ventilating, and Air Conditioning Systems, U.S. Department of the Interior Bureau of Reclamation, 2006
7. ISHRAE 2014
8. ASHRAE 2021 Applications
9. ASHRAE 62.1 Ventilation
10. ASHRAE 90.1 Energy

Resource person:

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Innovative Engineering Solutions,
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18AU0XM ADVANCED NAVIGATION ASSISTANCE THROUGH AUTOMOTIVE IOT
10 0 1

Course Objectives

- To educate the students on Automotive IoT followed in the industry for advanced navigation assistance.

Course Outcomes (s)

1. Identify IoT based problems
2. Provide solutions to Smart Factory problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		2	2											
2			2	2										

IoT Devices-IoT Gateways-Cloud Access-Cloud Components-Cross connectivity across IoT system Components-Device to Gateway –Short Range Wireless-Cell Phone as Gateway-Dedicated Wireless Access Point.-Wired-Cellular-Satellite-WAN-Direct Device to Cloud connectivity IoT Device Power Constraints-Powered and Unpowered Sensors-Power Harvesting-Energy-Storage-Technologies.Networking-Architectures-Star-Mesh-Tree Networking Protocols-TCP/IP-6LowPan-RPL-Thread - IoT Devices Application Level Protocols-MQTT-CoAP.IOT with Microsoft AZURE :IoT and Cloud deployment, Azure IoT Hub components, Azure IoT Hub Service API. Navigation through IoT tools.

Total: 15 Hours

Reference(s)

1. Kamlesh Lakhwani, Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, Internet of Things (IoT): Principles, Paradigms and Applications of IoT. India, BPB Publications, 2020.
2. Bharat Bhushan, Bhuvan Unhelkar, Lamia Karim, Muhammad Fazal Ijaz, Sudhir Kumar Sharma, Internet of Things: Frameworks for Enabling and Emerging Technologies. United States, CRC Press, 2022.

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18GE0XA ETYMOLOGY 1 0 0 1

Course Objectives

- To increase vocabulary and enhance use, knowledge, and understanding of the English language.
- To stimulate an appreciation for the English language, including how it developed, how new wordsenter the language, and how it continues to be dynamic.
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication.

Programme Outcomes (POs)

j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										2				
2										2				

UNIT I **7 Hours**

CONVENTIONS

Acronyms, Abbreviations, Initialises, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms ; Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym Apheresis - Blend word Assimilation - Colloquial language Clipped word

UNIT II **8 Hours**

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

Total: 15 Hours

Reference(s)

1. Norman, Lewis. Word Power Made Easy, Goyal Publisher. Edition 2. 2014.
2. C T Onions. The Oxford Dictionary of English Etymology, Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont, Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library. 1961.

18GE0XB GENERAL PSYCHOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of psychology.
- Defining Psychology and the subject matter of psychology.
- To provide an awareness of various methods and branches of psychology.
- To explain social and work psychology of people and the need for mental health.

Programme Outcomes (POs)

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large.
2. Understand the different fields of psychology and its uses.
3. Deal people effectively in their personal and social life.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1								2	1					
2								2	2					
3								2	3					

UNIT I **15 Hours**

GENERAL PSYCOLOGY

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology -Motivation- Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation- social influence- social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude.

Total: 15 Hours

Reference(s)

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016.
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education. 2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

18GE0XC NEURO BEHAVIORAL SCIENCE 1 0 0 1

Course Objectives

- To provide an introduction to the Cognitive Neuro Science oflanguages.
- To provide an understanding of the Cognitiveprocesses.

Programme Outcomes (POs)

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Identify the psychological problems that will impact mental health.
2. Value ethical conduct in professional and personal life.
3. Recognize the need for rationale and evidence in decision-making.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									1					
2									2					
3									3					

UNIT I **15 Hours**

NEURO BEHAVIOURAL SCIENCE

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds

Total: 15 Hours

Reference(s)

1. Beck, Robert. Handbook of Physiology. Vol I. Oxford University Press March 15,1996
2. Horon C Philip. Sexology and Mind. Academic Press. 1993
3. Blatteis M.Clark and Melvin J. Fregly. Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996

18GE0XD VISUAL MEDIA AND FILM MAKING 1 0 0 1

Course Objectives

- To acquire fundamental knowledge on development of filmmaking as an art
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issuesand the consequent responsibilities relevant to the professional engineering practice.

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, anddemonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2	2							
2						2	2							

UNIT I **15 Hours**

ART OF FILMMAKING

History of Cinema (Origin and Narrative) Cinema as a visual medium -Significance of Editing Styles of Editing Editing as a methodology (Hollywood s Invisible Editing) Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production) Different types of shots and angles

- Film style and Narrative (Italian Neo-realism, Avant Garde, Russain Formalism, Alternative Cinema etc.,) Regional Cinema to National Cinema Basics of Script Writing (Double and Single Column) Basics of Video Production (script to screen) Final submission of a script for five minutes short film

Total: 15 Hours

Reference(s)

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009.
2. Belavadi, Vasuki, Video Production. India: OUP, 2013.

18GE0XE YOGA FOR HUMAN EXCELLENCE 1 0 0 1

Course Objectives

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individualconsciousness
- To apply the knowledge by the way of practice and introspection

Programme Outcomes (POs)

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1								2	2					
2								2	2					
3								2	2					

UNIT I **15 Hours**

YOGA FOR HUMAN EXCELLENCE

What is Yoga , History of Yoga - Yoga in todays scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar Standing Asanas - Sitting Asanas
- Prone Asanas - Supine Asanas - MudrasRelaxation - Pranayama - Meditation

Total: 15 Hours

Reference(s)

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012.
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009.
3. Ramesh Partani, The Complete Secret, Ru Education, 2013.
4. http://www.sarvyoga.com/
5. http://www.wikihow.com/Do-Superbrain-Yoga

18GE0XF VEDIC MATHEMATICS 1 0 0 1

Course Objectives

- To improve their calculation speed, analytical thinking and numerical skills

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Solve problems creatively in mathematics and its applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3												

UNIT I **15 Hours**

VEDIC MATHEMATICS

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

Total: 15 Hours

Reference(s)

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997

18GE0XG HEALTH AND FITNESS 1 0 0 1

Course Objectives

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

Programme Outcomes (POs)

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretationof data, and synthesis of the information to provide valid conclusions.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issuesand the consequent responsibilities relevant to the professional engineering practice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Acquire the knowledge and training of the individual physical, mental and social concepts
2. Understand the fundamental concepts of yogic practice and physical fitness
3. To acquire the knowledge about nutrition and health consciousness

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							1		2					
2				2		2			2					
3				2		2			2					

UNIT I **5 Hours**

FITNESS

Meaning & Definition, Need & importance of Physical fitness, Types Physical fitness - Exercise, Training andConditioning and it is important

UNIT II **5 Hours**

YOGA AND MEDITATION

Meaning and definition; Principles of practicing;Basic Asana and it important; Pranayama and Meditation - Relaxation Techniques

UNIT III **5 Hours**

NUTRITION AND BALANCE DIET

Nutrition and Balance Diet: Needs and Important, Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases - cause prevention-First aid for common sports injuries.

Total: 15 Hours

Reference(s)

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House

2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics

3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers

4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications

5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited

18GE0XH CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING

1 0 0 1

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact procedures of biodegradation of unwanted solid residues

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Course Outcomes (COs)

1. Understand therole of recycling of garbage leading to thesustenance of our healthand environment.
2. Recognize the organic farming practices and production of healthy food products.
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2								
2						2								
3						2								

UNIT I **15 Hours**

VERMICOMPOSTING TECHNOLOGY

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipments, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle), vermicastings in organic farming/horticulture - Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours

Reference(s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops

18GE0XI BLOG WRITING **1 0 0 1**

Course Objectives

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
j. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

Course Outcomes (COs)

1. Understand the flow of language in natural manner.
2. Understand the elements of a blog and be able to use them effectively.
3. Find a niche for a long-term blog.
4. Gain insight into the strategies, methods and writing of successful bloggers.
5. Develop their creative thinking.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1										1				
2										1				
3						2								
4							2							
5							2							

UNIT I **7 Hours**

UNIT I

Concept: What is blog writing? Types of blog posts -personal experience, opinion, reviews, advice, news/updates. Focusing your blog - concept, audience, uniqueness, posts. Company blogs. Structure: Types of structure - inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

UNIT II **8 Hours**

UNIT II

Voice: Defining and achieving voice. Exploring various voices. Stylistic tipsÃƒÂ¢??rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. Reliability - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

Total: 15 Hours

Reference(s)

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. $29.95 paperback.
2. Blogging Heroes, by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Complete Guide to Blogging, Huffinghton Post

18GE0XJ INTERPERSONAL SKILLS 1 0 0 1

Course Objectives

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage ones own and others emotions
- To define and solve problems by making decisions about the best course of action

Programme Outcomes (POs)

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Express themselves clearly and confidently
2. Listen to others completely and with empathy
3. Assert an opinion without diminishing others opinion
4. Be responsible and timely with a willingness to collaborate
5. Develop innate personality traits to handle certain socialsituations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							2		2					
2							2		2					
3							2		2					
4							2		2					
5							2		2					

UNIT I **7 Hours**

INTRODUCTION

Conversational Skills - Active Listening - Team working Empathy - Emotional Intelligence

UNIT II **8 Hours**

SKILLS

Conflict Resolution and Mediation skills - Decision making and Problem Solving - Negotiation and Persuasion skills

Total: 15 Hours

Reference(s)

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014

1 0 0 1

18GE0XK COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT

Course Objectives

- Understand the role of National Service Scheme incommunity
- Identify the needs and problems of the community and involve in problemsolving
- Develop competence required for group living and acquire leadership qualities

Programme Outcomes (POs)
Course Outcomes (COs)

1. understand the community in which they work and render their service
2. develop among themselves a sense of social and civic responsibility

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1														
2														

UNIT I **15 Hours**

COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS- Emblem, flag, motto, song, badge- Organizational structure Ã¢?? roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, Day Camps-Basis of adoption of village/slums-Methodology of conducting Survey-Financial pattern of the scheme -Coordination with different agencies-Maintenance of the Diary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community-Identifying methods of mobilization-Youth-adult partnership. Health, Hygiene & Sanitation: Definition, needs and scope of health education- Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise-Role of financial and support service Institutions.

Total: 15 Hours

Reference(s)

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. http://nss.nic.in/intro.asp
3. Delgado-Gaitn and Concha, The Power of Community: Mobilizing for Family and SchoolingNew York: Rowman & Littlefield Publishing, Inc. 2001
4. James Bailey,Guide to Hygiene and Sanitation in Aviation, World health organization, 2nd edition. 1980
5. AnuradhaBasu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009

18GE0XL NATIONAL CADET CORPS 1 0 0 1

Course Objectives

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

Programme Outcomes (POs)

g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Recall the motto and aim of NCC.
2. Implement synergy in disaster management.
3. Execute an example patriotic leader to serve nation

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							2		2					
2							1		2					
3							1		2					

UNIT I **12 Hours**

NCC STRUCTURE AND TRAINING

NCC ORGANIZATION

National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.

DRILL AND WEAPON TRAINING

Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22 and INSAS - Stripping, Assembling and Cleaning of weapons.

NATIONAL INTEGRATION AND SOCIAL AWARENESS

National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGOs role and Contribution - Social Security schemes.

UNIT II **8 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

PERSONALITY DEVELOPMENT AND LEADERSHIP

Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader. DISASTER MANAGEMENT AND FIRST AID

Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defence: Civil defence measures - Civil defence services. First aid: First aid kits and Equipments - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

Total: 20 Hours

Reference(s)

1. Cadets Hand book Common subject, DG NCC, New Delhi.
2. Cadets Hand book Special subject, DG NCC, New Delhi
3. Misra R.C and Sanjaykumar Mishra, A HAND BOOK OF NCC(English), Kanti Prakashan, 2016
4. Gupta R. K, NCC: Handbook of NCC Cadets for A, B and C Certificate Examinations (English) RPHEditorial Board, 2018.

18GE0XM NEW AGE INNOVATION AND ENTREPRENEURSHIP 1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task of setting independent businessunits and on the various facets of running a business
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

Programme Outcomes (POs)

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women
4. Overview of Indian trends in the start-up scene

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2		2						
2						2		2						
3		2				2		2						
4			2			2		2						

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -MVPPositioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business PlanMentoring Session with Investors- Legal and Ethical Foundation for Startup. Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship

– Intrapreneurship Sustainability - Exit strategies and Start-up trends in India.

Total: 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, publishedby the authors, 2010
3. Branson. R. Ãƒ?Ã‚Â¢??Business stripped bareÃƒ?Ã‚Â¢??, New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh;CENGAGE/SOUTH WESTERN publisher, 2011

18GE0XN DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES

1 0 0 1

Course Objectives

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

Programme Outcomes (POs)

f. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

g. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Course Outcomes (COs)

1. Understanding contemporary entrepreneurship as an important career option
2. Concept and methodology of creative disruption to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women with disruptive technology option
4. Overview of Indian trends with reference to disruptive innovation based start-ups

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1							2	2						
2							2	2						
3							2	2						
4							2	2						

UNIT I **15 Hours**

DISRUPTIVE INNOVATION

Creativity linked innovation Ã¢?? Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new products and services to the market? Ã¢?? Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company"s capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly Ã¢?? Application of disruptive theories to complex problems and opportunities.

Total: 15 Hours

Reference(s)

1. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x
2. http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation
3. https://hbr.org/2006/12/disruptive-innovation-for-social-change

18GE0XO SOCIAL PSYCHOLOGY 1 0 0 1

Course Objectives

- To provide a basic understanding of social psychology.
- Defining psychological & physical changes during puberty age.
- To provide an awareness of various psychological problems and socialproblems.
- To explain social and work psychology of people and the need for mental health.

Programme Outcomes (POs)

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Course Outcomes (COs)

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the various psychological, physical, social problems and management skills.
3. Deal people effectively in their personal and social life.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2	2		1					
2						1	2		1					
3						2	2		3					

UNIT I **7 Hours**

INTRODUCTION

Introduction - Ice breaker - Time Line - Tasks and Challenges of the age(Erik Erikson)Physical changes - Introduction to Reproductive Health - Reproductive Organs - Menstruation - Changes during Puberty - Abortions - Contraception - Difference between Sex and Gender - Introduction to the origins of Patriarchy
- Gender.

UNIT II **8 Hours**

PSYCHOLOGY

Developmental changes - Attraction - Friendship - Differences and Similarities - Images of Beauty and Body Image -Introduction to Media-Feedback - Sexuality - Boundaries Relationships - Marriage - Love - Emotional Health - Sexual Abuse and Safety - Role of Media - Abortions, Contraception, Wrapping up the Course.

Total: 15 Hours

Reference(s)

1. Baron, R. A.,Branscombe.N.R.(2016).Social Psychology,14th Ed. New Delhi;Pearson Education
2. Morgan,C.T., King,R.A.,Weisz,J.R.,&Schopler,J.(1993). Introduction to Psychology,7th Ed.New Dehi:Tata McGraw Hill.

18GE0XP FM RADIO BROADCASTING TECHNOLOGY 1 0 0 1

Course Objectives

- The course focuses on community radio technology and various program productions techniques for FM Radio Broadcasting.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Course Outcomes (COs)

1. Understand the hardware required for field recording and setting up a studio and carry out studio and field recording.
2. Examine the available options for telephony interfaces for radio.
3. Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	2											
2	2	2	2											
3	2	2	2											

UNIT I **3 Hours**

INTRODUCTION TO AM/ FM RADIO

History of Radio-Types of Radio and its Reach- Entertainment Radio- Community Radio- Internet Radio- Satellite Radio. Evolution of Community Radio (CR) in India- principles behind setting up of FM/CR- policy guidelines and their impact on technology and content of a CR station- fundamental principles behind deciding the technology for a CR station.

UNIT II **3 Hours**

STUDIO TECHNOLOGY

Use of Microphones-Console handling-OB Recordings & Live Shows-Properties and components of sound- difference between analogue and digital audio-hardware required for field recording and setting up a studio- fundamental principles for setting up an audio studio.

UNIT III **3 Hours**

AUDIO PRODUCTION

Concept of recording and storing audio-hardware related to audio recording-open source software solutions for audio production-telephony interfaces for radio- audio Post Production. Voice Culture Exercise- Radio Production Techniques & Tools.

UNIT IV **3 Hours**

STUDIO OPERATIONS

Wiring, fixing of connectors, soldering and use of tools and equipment- preventive and corrective maintenance ofstudio and equipment.

UNIT V **3 Hours**

RADIO TRANSMISSION TECHNOLOGY

Components of the FM transmission chain- FM transmitter-different types of FM antenna - coaxial cable-propagation and coverage of RF signals-FM transmitter setup- Radio audience -measurements systems.

Total: 15 Hours

Reference(s)

1. UNESCO (2001). Community Radio Handbook.
2. Vinod Pavarala, Kanchan K Malik, Other Voices: The Struggle for Community Radio in India, SAGEPublications India, 2007.
3. Steve Buckley, Mark Raboy, Toby Mendel, Kreszentia Duer, Monroe E. Price, Sean O Siochru, Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation, University of Michigan Press, 2008.
4. www.floridasound.com
5. www.mediacollege.com
6. www.mediacollege.com

21AU001 ELECTRIC AND HYBRID VEHICLE 3 0 0 3

Course Objectives

- To understand the basics of electric and hybrid vehicles.
- To illustrate the drive system adopted for hybrid vehicles.
- To understand the different types of power electronic converter used in electric vehicles.
- To categorize electric storage devices for electric vehicle system.
- To explore the control strategies for vehicle drive system.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Identify the requirements of Electric Drivetrain for EVs and HEVs.
2. Analyze the different drive system and its efficiency for hybrid and electric vehicles.
3. Classify and explain the configuration layouts of Hybrid Vehicle Drive Trains.
4. Identify suitable electric storage devices for a particular application.
5. Infer the power system of various vehicular system and control strategies in EV.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	3	2											3	2
3	2	2	2										2	2
4	2	2											3	
5	3	3											3	2

UNIT I **10 Hours**

ELECTRIC VEHICLES

Layout of an electric vehicle, Performance of electric vehicles -traction motor characteristics, tractive effort, transmission requirements, energy consumption, Advantage and limitations.

UNIT II **8 Hours**

HYBRID VEHICLES

Hybrid electric drive trains- types of hybrid drive-train topologies, concepts, architecture, power flow control, Fuel efficiency analysis, Regenerative braking in HEVs-energy consumption during braking, limitation of energy recovery, control strategies, Plug-in hybrid, Merits and demerits.

UNIT III **9 Hours**

DRIVE SYSTEM

Introduction to electric components used in hybrid and electric vehicles- Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switched Reluctance Motor drives- drive system efficiency.

UNIT IV **9 Hours**

ENERGY STORAGE

Introduction to Energy Storage Requirements, Battery Fundamentals, Parameters and Modelling, Types, Battery based energy storage and its analysis: Types, Parameters and Modelling, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT V **9 Hours**

BATTERY CHARGERS

Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and-charge zone.

Total: 45 Hours

Reference(s)

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2011.
2. Mehrdad Ehsani, YimiGao, Sebastian E.Gay, Ali Emadi, "Modern Electric and Fuel Cell Vehicles, Theory and Design", CRC Press, 2009.
3. James Larminie,John Lowry,"Electric Vehicle Technology Explained", Wiley, 2012.
4. Ali Emadi.,"Advanced Electric Drive Vehicles",CRC Press, 2014.
5. Jack Erjavec.,"Hybrid, Electric, and Fuel-Cell Vehicles", Cengage Learning, 2012.

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21AU002 MATERIAL TECHNOLOGY FOR EV 3 0 0 3

Course Objectives

- To understand engineering materials and their properties.
- To evaluate the materials in manufacturing and design.
- To acquire knowledge on polymers and composite materials.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, basic engineering as it applies to automobile engineering to solve complex engineering problems

b. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them

c. Design and develop automobile systems , sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations

d. Design and conduct experiments, as well as analyze and interpret data related to automobile engineering

m. An ability to identify, analyze and solve engineering problems relating to Automobile systems together with allied engineering streams.

n. Modelling, design and Analysis of Automobile components using engineering design principles and software tools.

o. Capable of using the knowledge of basic sciences, computers in design / analysis and modern diagnostic tools in repair of subsystems in automobiles.

Course Outcomes (COs)

1. Identify the requirements engineering materials used in automobiles.
2. Analyze the different materials in manufacturing and design.
3. Analyze the mechanics of polymers.
4. Examine the composite materials.
5. Classify the different types smart materials and structures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2									2		
2	3	1		1										2	
3	2	3	1	3											
4	3	2		3											
5	3	1		1											

UNIT I **8 Hours**

ENGINEERING MATERIALS AND THEIR PROPERTIES

Classes of engineering materials – the evolution of engineering materials, Definition of materials properties, displaying material properties using materials selection charts, Forces for change in materials selection and design, Materials and the environment-selection of materials for automotive applications.

UNIT II **10 Hours**

MATERIALS IN MANUFACTURING AND DESIGN

Material selection on the basis of cost, strength, formability and machinability. Advanced strength analysis of heat-treated and cold formed parts including axial, bending, shear and cyclic deformation. Correlations of functional specifications and process capabilities. Problems in redesign for productibility and reliability.

UNIT III **10 Hours**

MECHANICS OF POLYMERS

Constitutive equation for linear small strain viscoelastic response; constant rate and sinusoidal responses; time and frequency dependent material properties; energy dissipation; structural applications including axial loading, bending, torsion; three-dimensional response, thermo-viscoelasticity, correspondence principle, Laplace transform and numerical solution methods.

UNIT IV **9 Hours**

COMPOSITE MATERIALS

Mechanics, Manufacturing and Design. Composite materials, including naturally occurring substances such as wood and bone, and engineered materials from concrete to carbon-fiber reinforced epoxies. Development of micromechanical models for a variety of constitutive laws. Link between processing and as-manufactured properties through coupled fluid and structural analyses.

UNIT V **8 Hours**

SMART MATERIALS AND STRUCTURES

Theoretical aspects of smart materials, sensors and actuator technologies. It will also cover design, modeling and manufacturing issues involved in integrating smart materials and components with control capabilities to engineering smart structures.

Total: 45 Hours

Reference(s)

1. Gladius Lewis, "Selection of Engineering Materials", Prentice Hall Inc. New Jersey USA, 1995.
2. Hiroshi Yamagata," The Science and Technology of Materials in Automotive Engines", Woodhead Publishing,2005
3. ASM Handbook. "Materials Selection and Design", Vol. 20- ASM Metals Park Ohio.USA, 1997.
4. ASM Handbook, "Selection of Materials Vol. 1 and 2", ASM Metals Park, Ohio. USA, 1991.
5. Cantor," Automotive Engineering: Lightweight, Functional, and Novel Materials", Taylor and Francis Group, London, 2006
6. James A. Jacobs, Thomas F. Kilduff., "Engineering Materials Technology: Structure, Processing, Properties and Selection", Prentice Hall, USA, 1996.
7. M F Ashby, "Materials Selection in Mechanical Design", third edition, Butterworth-Heineman, New York, 2005.

21AU003 EV VEHICLE DESIGN **3 0 0 3**

Course Objectives

- To understand EV design concepts.
- To acquire knowledge on design of powertrain for EV

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, basic engineering as it applies to automobile engineering to solve complex engineering problems

b. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them

c. Design and develop automobile systems , sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations

d. Design and conduct experiments, as well as analyze and interpret data related to automobile engineering

m. An ability to identify, analyze and solve engineering problems relating to Automobile systems together with allied engineering streams.

n. Modelling, design and Analysis of Automobile components using engineering design principles and software tools.

o. Capable of using the knowledge of basic sciences, computers in design / analysis and modern diagnostic tools in repair of subsystems in automobiles.

Course Outcomes (COs)

1. Analyse the different forces acting on the vehicle.
2. Examine the electric vehicle architecture design.
3. Analyse the electric motor and drive-controller design.
4. Examine the energy storage and charging station design.
5. Design for optimum body-structural and running-gear performance efficiency

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2									2		
2	3	1		1										2	
3	2	3	1	3											
4	3	2		3											3
5	3	1		1											

UNIT I **8 Hours**

INTRODUCTION

Vehicle Performance- Maximum Speed of a Vehicle, Gradeability, Acceleration Performance. Motor Torque Calculations for Electric Vehicle-Calculating the Rolling Resistance, calculating the grade resistance, Calculating the acceleration Force, Finding the Total Tractive Effort, Torque Required on The Drive Wheel, Vehicle Power Plant and Transmission Characteristics.

UNIT II **10 Hours**

ELECTRIC VEHICLE ARCHITECTURE DESIGN

Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV, Fuel cell electric vehicle (FCEV), Electrification, Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles

UNIT III **10 Hours**

ELECTRIC MOTOR AND DRIVE-CONTROLLER DESIGN

Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor , Electrical connection of motor, Brushless DC motor design for a small car, Brushless motor design for a medium car, High frequency motor characteristics, Innovative drive scheme for DC series motors.

UNIT IV **9 Hours**

ENERGY STORAGE AND CHARGING STATION DESIGN

Energy Storage - Battery charging and discharging calculation, Cell Selection and sizing, Battery lay outing design, Battery Pack Configuration, Battery Pack Construction, Battery selection criteria.

Charging station - Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station.

UNIT V **8 Hours**

DESIGN FOR OPTIMUM BODY-STRUCTURAL AND RUNNING-GEAR PERFORMANCE EFFICIENCY

Structural package and elements, 'Punt'-type structures, Optimizing substructures and individual elements, Designing against fatigue, Finite-element analysis (FEA), Running gear design for optimum performance and lightweight, Lightweight vehicle suspension,

8.10 Handling and steering, Traction and braking systems, Lightweight shafting, CV jointing and road wheels.

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Total: 45 Hours

Reference(s)

1. Bosch, Automotive Handbook, Warren dale PA: SAE International, 2004.
2. J.Powloski, Vehicle Body Engineering, London: Business books limited, 2014
3. R.K.Jurgen, Automotive Electronics Handbook, Second edition, London: McGraw-Hill Inc., 2006
4. D.Vivek, Ergonomics in the Automotive Design Process, Boca Raton: CRC press, Taylor and Francis group.
5. W.Johnson and A.G.Mamalis, Crashworthiness of Vehicles, London: MEP Publishers, 2005
6. R.Bishop, Intelligent Vehicle Technology and Trends, London: Artech House Publishers, 2005.

21AU004 POWER ELECTRONICS AND CONTROL OF ELECTRIC DRIVES

3 0 0 3

Course Objectives

- To analyze the static and switching characteristics of power semi-conductor devices.
- To understand the operation of controlled rectifiers.
- To understand and analyze the various types of choppers.
- To evaluate the operation, characteristics and performance parameters of Inverters.
- To understand the operation of ac-ac converters.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. PSO1: Modeling , design and Analysis of Electrical and Electronic Systems using design principles and software tools
n. PSO2: Develop electrical machineries/Appliances for various Domestic and industrial needs

Course Outcomes (COs)

1. Assess the static and dynamic characteristics of power semiconductor devices with the protection circuits.
2. Evaluate the input and output parameters of controlled rectifiers with R, RL and RLE Load.
3. Apply the various converter topologies to design and analyze the switched mode regulators
4. Examine the operation of inverter topologies with different PWM schemes.
5. Analyze the performance parameters of AC- AC converters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1											1	
2	3	2	1										3	
3	3	2	1										3	1
4	3	2	1										3	1
5	3	2											3	1

UNIT I **9 Hours**

POWER SEMI-CONDUCTOR DEVICES AND CONTROLLED RECTIFIERS

Construction Operation Static and Dynamics characteristics of Power Diode-Power BJT -SCR -DIAC - TRIAC- GTO -MOSFET - IGBT Ratings of Devices Protection of Devices.

Single Phase and Three Phase Half and Fully controlled rectifier with R, RL, RLE Load - Effect of Freewheeling Diode -Continuous and Discontinuous Mode of operation - Performance Analysis - Dual converter.

UNIT II **10 Hours**

CHOPPERS AND INVERTERS

Classification -control strategies - Buck, Boost, and Buck-Boost - Performance analysis - PWM techniques for choppers- Switched mode regulators

Single Phase H - Bridge and Cascaded H Bridge - Three Phase Voltage Source Inverters - Single phase and Three Phase Current Source Inverters - Performance analysis - PWM techniques. - Analysis of Harmonic Distortion.

UNIT III **8 Hours**

CONVERTER FED DC DRIVES

Microcontroller hardware circuit, flow charts waveforms, Performance characteristics of dc drives fed through single phase converters, 3-phase converters, dual converters, 1- phase fully controlled converter and 3-phase fully controlled converter fed dc drive

UNIT IV **12 Hours**

AC AND DC DRIVES

AC DRIVES-Starting, Braking and transient analysis, Calculation of energy losses, Speed control, Stator voltage control, Variable frequency control from voltage and current sources, Slip power recovery-Static Scherbius and Cramer drives.

DC DRIVES -Starting, Braking and Speed Control, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Phase controlled converter fed DC drives, Dual- converter control of DC drive, Supply harmonics, Power factor and ripple in motor current, Chopper Control DC drives, Source current harmonic in Choppers.

UNIT V **6 Hours**

CLOSED LOOP CONTROL OF MICROCOMPUTER BASED DRIVES

Voltage, Current, Torque and Speed measurements using digital measurement techniques. Types of controllers, position and velocity measurement algorithm, closed loop control of microcomputer-based drives

MODELING OF FREQUENCY CONTROLLED DRIVE Development of mathematical model for various components of frequency-controlled induction drive, mathematical model of the system for steady state and dynamic behaviour, Study of stability based on the dynamic model of the system.

Total: 45 Hours

Reference(s)

1. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications 4th Edition, Pearson India, 2017.
2. Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics: Converters, Applications and Design,3rd Edition WileyIndia, NewDelhi, 2007.
3. M.D. Singh & K.B Khanchandani. Power Electronics 2nd Edition Tata Mc Graw Hill Publishing Co.Ltd., New Delhi,2008.
4. D. Ronanki, S. Singh, S. Williamson, "Comprehensive Topological Overview of Rolling Stock Architectures and Recent Trends in Electric Railway Traction Systems", IEEE Trans. Transportation Electrification., vol. 3, no. 3, pp. 724-738, May 2017.
5. E. Babaei, S. Alilu, and S. Laali, Ã¢??A new general topology for cascadedmultilevel inverters with reduced number of components based on devel-oped H-bridge, IEEE Trans. Ind. Electron., vol. 61, no. 8, pp. 3932Ã¢??3939,Aug. 2014.
6. Vedam Subramanyam,"Electric Drives: Concepts and Applications", Tata McGraw-Hill, New Delhi, 2004.

7. Hamid A. Toliyat, "DSP Based Electromechanical Motion Control", 1st Edition, CRC Press, 2004.
8. Bose.B.K., Power Electronics and Motor Drives - Advances and Trends, IEEE Press, 2006.
9. Buxbaum, A. Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer- Verlag, Berlin,1990

21AU005 BATTERY MANAGEMENT SYSTEM 3 0 0 3

Course Objectives

- To introduce learner to batteries
- To understand the battery parameters.
- To explain the modelling and charging requirements.
- To help student to develop battery management algorithms for batteries.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Interpret the role of battery management system.
2. Identify the requirements of Battery Management System.
3. Interpret the concept associated with battery charging / discharging process.
4. Calculate the various parameters of battery and battery pack.
5. Design the model of battery pack.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	3	2											2	2
3	2	3	2										2	2
4	2	2											2	
5	2	2											2	2

UNIT I **10 Hours**

INTRODUCTION

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

UNIT II **8 Hours**

BATTERY MANAGEMENT SYSTEM REQUIREMENT

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and cell total power,

UNIT III **9 Hours**

BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION, CELL BALANCING

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing

UNIT IV

MODELLING AND SIMULATION

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, simulating an electric vehicle, Vehicle range calculations, simulating constant power and voltage, Simulating battery packs,

UNIT V **9 Hours**

DESIGN OF BATTERY BMS

Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system

Total: 45 Hours

Reference(s)

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

21AU006 AI & IoT for EV **3 0 0 3**

Course Objectives

- Understand the fundamental concepts of artificial intelligence
- Impart the different paradigms in knowledge representation and reasoning
- Understand the components and protocols used in IOT.
- To Understand the IoT Reference Architecture and Real-World Design Constraint

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, basic engineering as it applies to automobile engineering to solve complex engineering problems

b. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them

c. Design and develop automobile systems, sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations

d. Design and conduct experiments, as well as analyze and interpret data related to automobile engineering

m. An ability to identify, analyze and solve engineering problems relating to Automobile systems together with allied engineering streams.

n. Modelling, design and Analysis of Automobile components using engineering design principles and software tools.

o. Capable of using the knowledge of basic sciences, computers in design / analysis and modern diagnostic tools in repair of subsystems in automobiles.

Course Outcomes (COs)

1. Understand the awareness of intelligent agents and problem solving using uninformed, informed, and local search methods.
2. Apply and integrate various artificial intelligence techniques in intelligent system development.
3. Identify physical design, components and communication models used in IOT
4. Implement sensor interfacing and collaborate them with network devices.
5. Identify protocols used for connecting devices to cloud and web servers

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2		2								2		
2	2	2	2		2									2	
3	2	3	3		3										
4	2	2	2		2										3
5	1	2	2		2										

UNIT I **8 Hours**

AI SEARCHING TECHNIQUES AND KNOWLEDGE REPRESENTATION

Intelligent Agents - Agents and environments - Good behavior - The nature of environments - Structure of agents - Problem Solving - Problem solving agents- Uniformed search strategies. Searching Techniques - Informed search and exploration - Informed search strategies - heuristic function - Local search algorithms and optimization problems- Local search in continuous spaces - -Constraint satisfaction problems (CSP).

Knowledge Representation- First order logic - Representation revisited - Syntax and semantics for first order logic - Using first order logic -Knowledge engineering in first order logic - Inference in First order logic - Prepositional versus first order logic

UNIT II **10 Hours**

PLANNING AND LEARNING

Planning - Planning problem- Planning with state space search - Partial order planning - Planning graphs – Planning with proportional logic - Time, Schedules, and Resources - Hierarchical task Planning – Conditional Planning - Execution monitoring and re planning- Continuous planning.

Learning - Learning from observations - forms of learning - Inductive learning - Learning decision trees – Ensemble learning - Knowledge in learning - Logical formulation of learning -Explanation based learning - Learning using relevant information-Statistical Learning Methods.

UNIT III **10 Hours**

INTRODUCTION TO IOT AND REFERENCE ARCHITECTURE

IOT Fundamentals - Characteristics of IoT - Physical Design of IoT - IoT Protocols - IoT communication models - IOT Communication APIs -IOT enabled Technologies - Wireless Sensor Networks, Cloud Computing, Big data analytics, and Communication protocols, IOT Levels and Templates.

Architecture Reference Model- IOT reference Model-IOT Protocols: Zigbee, RFID, BLE, NFC, BACnet, 6LowPAN, RPL, XMPP, CoAP, and MQTT.

UNIT IV **9 Hours**

IOT DEVICES AND INTERFACING

IOT components - Sensors - Actuators - Hardware Platforms - Interfacing with devices: Setting up the board -Programming for IOT - Reading from Sensors, Communication: Connecting microcontroller with mobile devices - communication through Bluetooth, wifi, Ethernet.

UNIT V **8 Hours**

IOT CLOUD, WEB SERVICES AND DATA ANALYTICS

Introduction to Cloud Storage models - Cloud services and IOT - communication APIs -Cloud for IOT - Web server: Web server for IOT - Amazon Web services for IOT- Data analytics for IOT. IOT SECURITY - Security Requirements in IOT - Security Concerns in IOT Applications - Security Architecture in the Internet of Things - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IOT.

Total: 45 Hours

Reference(s)

1. Stuart Russell and Peter Norvig, Artificial Intelligence - A Modern Approach, Prentice Hall India, 2012
2. Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw-Hill, 1997.
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David
4. Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014.
5. Vijay Madisetti and ArshdeepBahga, Internet of Things (A Hands-on-Approach), 1stEdition, VPT, 2014.
6. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things Key applications and Protocols, Wiley, 2012
7. Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects) [Kindle Edition] by CunoPfister,2011.

21AU007 SAFETY REGULATIONS AND TESTING OF EV

3 0 0 3

Course Objectives

- To understand about the testing of electric vehicle
- To develop knowledge required for validation of vehicle components and systems
- To know about the dynamics testing of vehicle

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, basic engineering as it applies to automobile engineering to solve complex engineering problems
b. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them
c. Design and develop automobile systems, sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations
d. Design and conduct experiments, as well as analyze and interpret data related to automobile engineering
m. An ability to identify, analyze and solve engineering problems relating to Automobile systems together with allied engineering streams.
n. Modelling, design and Analysis of Automobile components using engineering design principles and software tools.
o. Capable of using the knowledge of basic sciences, computers in design / analysis and modern diagnostic tools in repair of subsystems in automobiles.

Course Outcomes (COs)

1. Understand about the testing of electric vehicle.
2. Understand the procedure for vehicle testing.
3. Analyze the different types of vehicle static testing.
4. Examine the dynamics testing.
5. Analyse the Hybrid testing and charging station.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	2	3								2		
2	3	1		1	2									2	
3	2	3	1	3	2										
4	3	2		3	2										3
5	3	1		1	2										

UNIT I **8 Hours**

HOMOLOGATION, CERTIFICATION

Specification & Classification of Vehicles (including M, N and O layout), Homologation & its Types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks, Hardware in The Loop (HIL) concepts for EV/HEVs.

UNIT II **10 Hours**

VEHICLE TESTING

Durability Testing -Types, Procedures & Measurements Methods, Components validation -Types , Procedures & Measurements Methods, Testing Measurement Instruments - Types ,Procedures & Measurements Methods, Vehicle Calibration & Testing -Types , Procedures & Measurements Methods.

UNIT III **10 Hours**

STATIC TESTING OF VEHICLE

Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls for M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement of Temporary Cabin For Drive– Away – Chassis, Electric vehicle – Safety Norms, Energy consumption and Power test.

UNIT IV **9 Hours**

DYNAMICS TESTING OF VEHICLE

Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test, Electric vehicle – Range Test.

UNIT V **8 Hours**

TESTS FOR HYBRID ELECTRIC VEHICLES, RETRO-FITMENT AND CHARGING STATION

Hybrid Electric Vehicles Tests (M and N category), Tests for Hybrid Electric System Intended for Retro-fitment on Vehicles of M and N Category (GVW < 3500 kg), Test for Electric Propulsion kit intended for Conversion, Test for Electric Vehicle Conductive AC Charging System, and Test for Electric vehicle conductive DC charging system

Total: 45 Hours

Reference(s)

1. Bosch, Automotive Handbook, Warren dale PA: SAE International, 2004.
2. Michael Plint& Anthony Martyr, “Engine Testing & Practice”, Butterworth Heinmenn, 3rd ed, 2007
3. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI PUNE
4. Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007

21AU008 EV CHARGING AND FUEL CELLTECHNOLOGY

3 0 0 3

Course Objectives

- Understand the basic characteristics of batteries and its charging requirements.
- Analyse the various types of chargers and technologies for EV charging technology.
- Outline the management systems and smart control in EV charging technology.
- To study about the various types of fuel cells and hydrogen fuelling.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. Modeling, design and Analysis of Electrical and Electronic Systems using design principles and software tools

Course Outcomes (COs)

1. Analyse the characteristics of batteries and charger requirements in Electric vehicle.
2. Analyse the various performance parameters of converters in ON board charger for Electric Vehicles.
3. Analyse the concept of power converters to design OFF board charger for Electric Vehicles.
4. Explain the various types of fuel cells.
5. Explain the hydrogen fuelling

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3												
2	2	2	1										1	
3	1	3	2										1	
4	1	3	2										1	
5	1	2	2										2	

UNIT I **8 Hours**

CHARACTERISTICS OF ELECTRIC VEHICLE BATTERIES

Types of batteries-Characteristics of Electric vehicle battery-Lead Acid battery-Lithium Ion battery-AH rating-C-rate-Charging and discharging characteristics-Exponential area-Charger requirements-Types of charging methods.

UNIT II **9 Hours**

ON BOARD CHARERS AND OFF BOARD CHARGERS

LEVEL 1 and 2 Charger-Topology for On board charger-AC/DC Converters-Front end converter-Output and input analysis -Unidirectional and Bidirectional power flow-Multifunctional on board chargers-IEC and IEEE standards of On board charger-charger ports

LEVEL 3 Charger-Bidirectional AC/DC Converter-Bidirectional DC/DC Converter-Unidirectional AC/DC Converter-Unidirectional DC/DC Converter-Vienna Rectifier-Phase Shift full bridge converter-IEC and IEEE standards of Off board charger-Charger port

UNIT III **10 Hours**

FAST CHARGERS AND STATION MANAGEMENT

Need for Fast charging-Architecture of Fast charger-Fast charging station with Unipolar DC voltage bus-Fast charging station with Bipolar DC voltage bus-Wireless charging-Impacts of fast charger on grid
Smart Charging Station-Management and supervisory Control system-business model of charging points-Vehicle to Grid(V2G) interactions-Impacts on grid-power quality issues-Load management challenges.

UNIT IV **9 Hours**

FUEL CELLS

Introduction-working and types of fuel cell-Low, medium and high temperature fuel cell, Liquid and methanol types, Proton exchange fuel cell solid oxide, hydrogen fuel cells-Thermodynamics and electrochemical kinetics of fuel cells.
Fuel cell performance characteristics- Current/voltage, voltage efficiency and power density, Ohmic resistance, Kinetic performance, mass transfer effects-membrane electrode assembly components, fuel cell stacks, bi-polar plate, humidifiers and cooling plates.

UNIT V **9 Hours**

FUELING

Hydrogen storage technology-pressure cylinders, liquid hydrogen, metal hydrides, methods of hydrogen production, carbon fibres-reformer technology- steam reforming, partial oxidation, auto thermal reforming-CO removal, fuel cell technology based on removal like bio-mass

Total: 45 Hours

Reference(s)

1. D Smith,Electric Vehicle Charging Station (EVCS): Renewable Energy meets the Ultra-Low Emission Vehicle,2015
2. Morris Brenna, Federica Foiadelli, Carola Leone, Michela Longa,Electric Vehicles Charging Technology Review and Optimal Size Estimation,Journal of Electrical Engineering & Technology, 2020.
3. Tianjin Chen, Xiao-Ping Zhang, Jianji Wang, Jianing Li, Cong Wu, Mingzhu Hu, and Huiping Bian,A Review on Electric Vehicle Charging Infrastructure Development in the UK, Journal of Modern Power Systems and Clean Energy, Vol. 8, No. 2, March 2020
4. Mary Fitzpatrick,Electric Vehicle Charging Stations,Connecticut General Assembly,Office of Legislative Research,2016
5. Tariq Munneer,Mohan Khole, Aisling Doyle,Electric Vehicles:Prospects and challenges, Elsevier Science, 2017
6. Frano Babir, "PEM FUEL CELLS: Theory and Practice", Elsevier Academic Press, USA, 2005.
7. Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2006.
8. Fuel cells for automotive applications - professional engineering publishing UK, 2004.
9. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modem Electric, Hybrid Electric and Fuel cell Vehicles", Fundamental, Theory and design", CRS Press, 2004.

21AU009 AUTONOMOUS AND CONNECTED VEHICLES 3 0 0 3

Course Objectives

- To impart knowledge on autonomous vehicle and driver assistant systems
- To understand the key aspects of In-Vehicle Infotainment System
- To understand the operating strategies of technologies under autonomous vehicles

Programme Outcomes (POs)

b. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them

c. Design and develop automobile systems , sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations

e. Use appropriate techniques , modern engineering/IT/ product development tools and mathematical /computer-based models with an understanding of the limitations

m, An ability to design, analyze and find the solutions for automotive related problems.

n. Capable of using the knowledge of basic sciences, computers in design / analysis and modern diagnostic tools in repair of subsystems in automobiles.

Course Outcomes (COs)

1. Gain knowledge on different driver assistant system of autonomous vehicle and their applications
2. Understand the Radio communication technologies for Intelligent Vehicles
3. Discuss the key trends and concepts of In Vehicle Infotainment System.
4. Explain the various security systems associated with vehicle system
5. Implement the modern day technologies of autonomous vehicles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1		2	3		1								1	1
2		2	3		1								1	3
3		3	2		2								3	2
4		2	2		1								2	1
5		3	3		1								3	1

UNIT I

AUTONOMOUS DRIVING TECHNOLOIES -INTRODUCTION

Levels of Driving Automation, Architecture for Autonomous System – Hardware and Software Architecture, Computer vision, Deep learning, Sensor fusion – localization - path planning – decision and Control - System integration.

UNIT II **9 Hours**

RADIO COMMUNICATION AND INTELLIGENTTRANSPORTATION-SYSTEMS

Introduction – ITS communication systems, Multimedia communication in a car, Current ITS communication systems and services - Inter-vehicle communication system - Road-vehicle communication system - Device technologies.

UNIT III **9 Hours**

FUNDAMENTALS OF INFOTAINMENT SYSTEM

Introduction to In Vehicle Infotainment (IVI) systems, Use of operating systems in IVI - GENIVI Alliance-Tuner- AM/FM - XM/Sirrus - DAB/DMB - Software Defined Radio - Ensemble - Traffic Announcements - Spread Spectrum, Multimedia: Types of Media. Navigation- Points of Interests - Routes - Waypoints - Dead Reckoning position, Traffic Info - GLONASS - GNSS - RTK - GPS - and SBAS/GBAS, INS - System Architecture – Design Patterns - Proxies - Adaptors - Interfaces - Singleton - Factory method.

UNIT IV **9 Hours**

TELEMATICS & SECURITY SYSTEMS

Telematics-Global positioning systems - geographical information systems - navigation systems - automotive vision system - road recognition - driver assistance systems. Security Systems- Vehicle Immobilzers - Anti theft technologies - smart card system - number plate coding.

UNIT V **9 Hours**

ADAVANCED DRIVER ASSISTANCE AND SAFETY SYSTEM

Active Safety Systems -and Passive Safety Systems - Advanced Driver Assistance Systems (ADAS)-Combining computer vision techniques as pattern recognition - feature extraction - learning - tracking - 3D vision to assist the driving activity. Examples of assistance applications- Lane Departure Warning, Collision Warning, Automatic Cruise Control, Pedestrian Protection, Headlights Control, Connected Cars technology and trends towards Autonomous vehicles.

Reference(s)

1. Intelligent Vehicle Technologies - Ljubo Vlacic, Michel Parent and Fumio Harashima,“”, Butterworth-Heinemann publications, Oxford, 2001.
2. William B Ribbens , "Understanding Automotive Electronics", Butter worth Heinemann Woburn, 2012.
3. Yunpeng Wang, Daxin Tian, Zhengguo Sheng, Wang Jian , "Connected Vehicle Systems: Communication, Data, and Control", 2nd Edition , CRC publisher, 2017.
4. Ronald K Jurgen, Navigation and Intelligent Transportation Systems - Progress in Technology, Automotive Electronics Series, Warrendale, PA: SAE International, 2014
5. Robert Bosch,Automotive Hand Book, Warrendale, PA: SAE International, 2014
6. Hong Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.

21AU010 SENSORS AND ACTUATORS 3 0 0 3

Course Objectives

- To impart knowledge on sensors in the field of automotive electronics.
- To understand the process of interfacing sensors & actuators
- To understand the fault diagnosis of sensors in modern day vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Select suitable sensors for measuring parameters in automotive systems
2. Choose the appropriate actuator and driver for automotive applications
3. Build codes for automotive embedded applications
4. Discuss the key trends and concepts of In Vehicle Infotainment System.
5. Implement fault diagnosis on automotive electrical system.
6. Explain the role of electronics in modern day vehicles

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	3										1	1
2	2	2	3										1	3
3	1	3	2										3	2
4	1	2	2										2	1
5	1	3	3										3	1

UNIT I **9 Hours**

AUTOMOTIVE SENSORS

Introduction to automotive sensors, Proximity sensors- inductive, capacitive, magnetic, Photoelectric, Ultrasonic sensors, Thermistor, Thermocouple, Hall effect sensor, Load cell, Optical rain sensor, Liquid level sensor, Lambda sensor, NOX sensor, MAP and MAF, Knock sensor, Angle sensor, Vibration sensor, Acceleration sensor, Pressure sensor, RPM sensor, Torque sensors, Position sensor.

UNIT II **9 Hours**

ACTUATORS

Solenoid –Types , Solenoid Switching, Relays and Optoisolators – Electromechanical relay, driving a relay, solid-state relay, Reed switch , Optoisolator, Operation and application of BLDC motors, Servo and stepper motors, Piezoelectric Actuators, Actuator Driver - H Bridge driver, Door actuator driver, Stepper motor driver, Transistor driver, Signal conditioner - Amplifier, Filter, Data Acquisition.

UNIT III **9 Hours**

INTERFACING OF SENSORS

Analog to digital converter - ADC 0804 with LM35 temperature sensor - Signal conditioning. Motor Interfacing: Relay logic - Pulse width modulation - Speed control of DC motor using PWM - Stepper motor interfacing with automotive applications.

UNIT IV

ELECTRICAL SYSTEM FAULT DIAGNOSIS **9 Hours**

Introduction to electronic components and circuits - multiplexing and De multiplexing lighting system faults and auxiliary faults in-car. Entertainment security and communications implementation body-electrical systems - instruments system faults - heating ventilation and air conditioning - Cruise control - air bags and belt tensioners - Cycle test-I - Cycle test-II.

UNIT V

ELECTRONICS IN AUTOMOBILE **9 Hours**

Introduction- Body and convenience electronics: vehicle power supply controllers and lighting modules - door control modules - Safety electronics: active safety systems: ABS - ASR - ESP passive safety systems: Restraint systems and their associated sensors in an automobile. Infotainment electronics: Dashboard/instrument cluster - car audio - telematic systems - navigation systems - multimedia systems.

Reference(s)

1. Denton T , " Automobile Electrical and Electronic Systems", Routledge, 2013.
2. Bosch , "Automotive Electric and Automotive Electronics", 5th Edition, Springer Fachmedien Wiesbaden, 2014.
3. William B.Riddens , "Understanding Automotive Electronics: An Engineering Perspective", 8th Edition, Elsevier, 2017.
4. Nicholas Navit , "Automotive Embedded System Handbook", CRC Press Publications, 2013.
5. Electronic control unit (ECU). In: Reif K. (eds) Gasoline Engine Management. Bosch Professional Automotive Information by Kaiser M. (2015)
6. Sensors and Transducers - Ronald K. Jurgen, —, 2nd Edition, SAE, 2003
7. Automotive Sensors, BOSCH. 2002
8. Automotive Electronics Design Fundamentals 1st ed. 2015 Edition by Najamuz Zaman

21AU011 AUTOMOTIVE EMBEDDED SYSTEMS 3 0 0 3

Course Objectives

- To introduce the automotive embedded systems
- To understand Automotive Sensory Systems
- To explain the importance of automotive control in system design
- To make student aware of different automotive protocols for vehicle communication

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Explain the fundamentals of Embedded Systems
2. Outline the working of sensors and instrumentation in vehicle systems
3. Design control system for various vehicular modules
4. Summarize the technical interfacing requirements for the development of embedded System
5. Analyze the various automotive protocols

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-											-	
2	-	-											-	-
3	-	-	-										-	-
4	-	-											-	
5	-	-											-	-

UNIT I **9 Hours**

EMBEDDED SYSTEM FUNDAMNETALS

Introduction, Embedded system design process, Microcontroller v/s microprocessor, Architecture of 8/32 Bit controller - ADC, DAC, Memory, Timer and interrupts. Software development in IDE - Hardware/ Software configuration, Models of programs - Assembly, linking and loading. Structure of the Program - variables, functions, loops and I/O parameters.

UNIT II **8 Hours**

AUTOMOTIVE SENSORS

Automotive Sensors and Transducers: Temperature, Manifold and Barometric Pressures, Humidity, Carbon Dioxide (CO2),Carbon Monoxide (CO), Oxygen (O2) Sensor, Proximity Distance Sensors, Engine Speed sensor, Throttle Position Sensor, Pressure Sensors, Knock Sensor & Mass Flow Sensor. Typical Sensors Specifications & Microcontroller Interface Considerations, Sensor Calibration, Curve fitting.

UNIT III **9 Hours**

AUTOMOTIVE CONTROL SYSTEM DESIGN

Digital Engine Control, Features, Control Modes for Fuel Control, Discrete Time Idle Speed Control, EGR Control, Variable Valve Timing Control, Electronic Ignition Control, Integrated Engine Control System, Summary of Control Modes, Cruise Control System, Cruise Control Electronics, Anti-locking Braking System, Electronic Suspension System, Electronic Steering Control, Four-Wheel Steering.

UNIT IV **9 Hours**

INTERFACING WITH MICROCONTROLLER

Sensor Interfacing: Analog and digital sensor, keyboard interface with 8/32 bit controller. Actuator Interfacing: Motor control applications - Pulse width modulation (PWM), LCD display, relay and solenoid Interfacing with 8/32 bit controller. Serial communication inter facing.

UNIT V **9 Hours**

AUTOMOTIVE PROTOCOLS

The need for Protocol , Automotive Protocols : LIN, CAN, KWP2000 & J1939, Flex Ray, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools , ECU Calibration Tools , Vehicle Network Simulation. Advanced Trends in Automotive Electronics: AUTOSAR Architecture.

Total: 45 Hours

Reference(s)

1. William B. Ribbens, Understanding Automotive Electronics-An Engineering Perspective, Seventh edition, Butterworth-Heinemann Publications.G.E. Dieter, Engineering Design - A Materials and process approach, Tata McGraw-Hill,2008
2. Sensors and Transducers - Ronald K. Jurgen, 2nd Edition, SAE, 2003
3. Automotive Sensors, BOSCH. 2002
4. Najamuz Zaman, Automotive Electronics Design Fundamentals 1st ed. 2015 Edition
5. Wilfried Voss, Comprehensible Guide to Controller Area Network Paperback - 1 Aug 2005.

21AU012 AUTOMOTIVE COMMUNICATION PROTOCOLS 3 0 0 3

Course Objectives

Provide knowledge in concepts of acquiring ECU data, storage and exchange of data for ECU Communication in-vehicle network systems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

m. An ability to design, analyze and find the solutions for automotive related problems

n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Outline the concepts of communication protocols
2. Explain the working of CAN network in the In Vehicle Architecture of a vehicle
3. Explain the working of LIN network in the In Vehicle Architecture of a vehicle
4. Summarize the technical interfacing requirements FlexRay Network protocol in vehicle
5. Apply the knowledge communicative protocols to In vehicle network diagnostics

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	3	2											2	2
3	2	2	2										2	2
4	2	2											2	
5	2	2											2	2

UNIT I **9 Hours**

NETWORKING FUNDAMENTALS OF EMBEDDED SYSTEM

Introduction- Serial/Parallel Communication, Serial communication protocols -RS232 standard, RS485 – Synchronous Serial Protocols, Serial Peripheral Interface (SPI), Inter Integrated Circuits (I2C), PC Parallel port programming -ISA/PCI Bus protocols, Firewire USB bus, Speed Identification on the bus, USB States , USB bus communication: Packets, Data flow types, Enumeration, Descriptors, PIC 18 Microcontroller USB Interface – CPrograms.

UNIT II **8 Hours**

CONTROLLER AREA NETWORKING PROTOCOL

History and foundation of CAN, CAN Applications, Main characteristics of CAN, CAN in OSI Reference Model, CAN Data Link Layer, Principles of data exchange in CAN, Arbitration, Data Frame, Remote Frame, Error detection and management in CAN, CAN physical Layer, Bit encoding, Bit timing and synchronization, Relationship between data rate and bus length, Single wire and twin wire media,CAN repeaters, Medium-to-medium gateway, Protocol handlers, Micro-controllers and line drivers, Time-Triggered CAN (TTCAN), CANoe based applications development..

UNIT III **9 Hours**

LOCAL INTERCONNECT NETWORKING PROTOCOL

Introduction to LIN, LIN consortium, LIN specification, LIN features, Technical overview, Work flow concept, LIN operation, LIN frame format, Scheduling table, Network management of LIN cluster, LIN Transport Layer, LIN node configuration and identification, LIN diagnostics, LIN physical layer.

UNIT IV **9 Hours**

FLEXRAY PROTOCOL

Future on board systems, Need for FlexRay, Origin of FlexRay, FlexRay consortium, FlexRay Objectives, FlexRay Features, Application requirements, Working of FlexRay, Network topologies, ECU architecture, Segment Configuration, Communication Cycles, FlexRay frame format, Timing of configuration protocol, Error control, and FlexRay core mechanisms,Coding and Decoding, Medium Access Control, Frame and Symbol Processing, Clock Synchronization, FlexRay Components.

UNIT V **9 Hours**

IN VEHICEL NETWORK DIAGNOSTICS

Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop), On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study

Total: 45 Hours

Reference(s)

1. Multiplexed Networks for Embedded Systems - by Dominique ParetPublisher: John Wiley & SonsRelease Date: July 2007.
2. Understanding and Using the Controller Area Network Communication Protocol: Theory and Practice -Marco Di Natale(Author), Haibo Zeng(Author), Paolo Giusto(Author), ArkadebGhosal – springer 2012.
3. Embedded Networking with CAN and CANopen Paperback – June 28, 2016 by Olaf Pfeiffer (Author), Andrew Ayre (Author), Christian Keydel (Author) -Embedded Systems Academy Inc.; 1 edition (June 28, 2016)

21AU013 VEHICLE CONTROL SYSTEMS 3 0 0 3

Course Objectives:

- To understand the basics of control system used in automobiles.
- To recognize the electronically controlled system used in driving mechanics.
- To understand the working principle of driver modelling and power train control systems.
- To identify the control system used in hybrid and electrical vehicles.
- To illustrate the need of automated transport systems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Understand the basics of control system used in automobiles
2. Recognize the electronically controlled system used in driving mechanics.
3. Understand the working principle of driver modelling and power train control systems.
4. Identify the control system used in hybrid and electrical vehicles.
5. Illustrate the need of automated transport systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2											2	
2	2	3											2	2
3	2	2	2										2	2
4	2	2											2	
5	2	2											2	2

UNIT I **9 Hours**

INTRODUCTION TO VEHICLE CONTROL SYSTEM

Trends, overview and examples of vehicle control system- Sensors, actuators and controller modules- Vehicle communication Network- System Engineering V- diagram- Algorithm Development - Steps in vehicle control system design- Degree of freedom for vehicle control- selection of controlled, manipulated, measured disturbance variables- classificationof the variables in various automotive systems like engines, suspension, braking, air

conditioning – General types of vehicle controller configurations- Feedback, Inferential, Feed- Forward, Ratio control.

UNIT II **9 Hours**

CONTROL SCHEMES, CRUISE AND HEADWAY CONTROL

Feed - Forward control - Cascade control- Design considerations for cascade control, Time delay compensation, Inferential control- Nonlinear control- Adaptive control etc. Cruise control design- Autonomous cruise control- Anti locking brakes- Traction control system- Vehicle stability control linear and non- linear vehicle model- VSC Design Principles – four-wheel steering – Goals of 4WS Algorithms – active suspensions.

UNIT II **9 Hours**

DRIVER MODELING AND POWERTRAIN CONTROL SYSTEMS

Driving simulators- percentage of road departure- Driver modeling- Transfer function models- Preview/ Predictive models- longitudinal driver models Control oriented engine modeling- Air intake model- Fuel dynamics model- Air Fuel ratio dynamics- Engine Control Loops- Air Fuel Ratio control- EGR Control- Spark Timing control- Idle speed control- Knock control- Adaptive knock control- Combustion torque estimation- Transmission control.

UNIT II **9 Hours**

CONTROL OF HYBRID AND FUEL CELL VEHICLES

Series- Parallel- Split Hybrid Configurations- Hybrid Vehicle Control Hierarchy- Control Concepts of Series Hybrids- Equivalent Consumption minimization strategy- control concepts for split hybrid modelling of fuel cell systems- fuel stack model- control of fuel cellsystem.

UNIT II **9 Hours**

HUMAN FACTORS AND INTELLIGENT TRANSPORT SYSTEM

Human factors in vehicle automation- cross over model principle- Risk- Homeostatic Theory- Driving simulators- percentage of road departure Advanced traffic management system- Advanced traveller information system- commercial vehicle operation- Advanced vehicle control system- Preventing collisions- Longitudinal motion control and platoons-Site specific information- comparison of longitudinal control approaches- String stability- Automated steering and lateral control – Lane sensing- automated lane change and follow control.

Total: 45 Hours

Reference(s)

1. Galip Ulsoy , Automotive Control System, Cambridge University Press, 2012
2. Uwe Kiencke and Lars Nielson, Automotive Control System, SAE Publications, 2006
REFERENCES:
1. Bosch Automotive Handbook, Sixth Edition,2004

2. Benjamin C.Kuo and Farid Golnaraghi, Automatic Control System, John Wiley & Sons,Eight edition, 2003.
3. Katsuhiko Ogata, System Dynamics, Prentice Hall International, Inc. Third Edition,1998
4. Richard C.Dorf and Robert H.Bishop, Modern Control Systems, Pearson Prentice Hall,2008

21AU014 MACHINE LEARNING FOR AUTONOMOUS VEHICLE 3 0 0 3

Course Objectives

- To understand the concepts of Machine Learning.
- To appreciate supervised learning and their applications.
- To appreciate the concepts and algorithms of unsupervised learning.
- To understand the basic concept of reinforcement learning algorithm and its applications.
- To study about modelling, aggregation and knowledge representation using graphical models.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
f. An ability to design, analyse and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Identify applications suitable for different types of Machine Learning with suitable justification.
2. Implement supervised Learning algorithms for real time data sets for Intelligent decision making.
3. Apply Machine Learning techniques to classification and clustering to unstructured data.
4. Apply reinforcement learning techniques for real life problems.
5. Implement probabilistic discriminate and generative algorithms for applications of your choice and analyze the results.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	2									2	
2	1	2	2	2	1	1							2	
3	1	1	2	1	1	2								
4	1	2	1											
5	1	2	2	2										

UNIT I **9 Hours**

INTRODUCTION TO MACHINE LEARNING

Machine Learning - Machine Learning Foundations - Overview - applications - Types of machine learning - basic concepts in machine learning Examples of Machine Learning -Applications - Linear Models for Regression - Linear Basis Function Models - The Bias-Variance Decomposition - Bayesian Linear Regression - Bayesian Model Comparison.

UNIT II **9 Hours**

SUPERVISED LEARNING

Linear Models for Classification - Discriminant Functions -Probabilistic Generative Models - Probabilistic Discriminative Models - Bayesian Logistic Regression. Decision Trees - Classification Trees- Regression Trees - Pruning. Ensemble methods- Bagging- Boosting.

UNIT III **9 Hours**

UNSUPERVISED LEARNING

Clustering- K-means - EM - Mixtures of Gaussians - The EM Algorithm in General -Model selection for latent variable models - high-dimensional spaces - The Curse of Dimensionality -Dimensionality Reduction - Factor analysis - Principal Component Analysis - Probabilistic PCA- Independent components analysis.

UNIT IV **9 Hours**

REINFORCEMENT LEARNING

Passive reinforcement learning- direct utility estimation- adaptive dynamic programming- temporal difference learning- active reinforcement learning- exploration- learning an action-utility function- Generalization in reinforcement learning- policy search- applications in game playing- applications in robot control.

UNIT V **9 Hours**

PROBABILISTIC GRAPHICAL MODELS

Graphical Models-Undirected Graphical Models-Markov Random Fields-Directed Graphical Models-Bayesian Networks-Conditional Independence properties-Markov Random Fields-Hidden Markov Models-Conditional Random Fields(CRFs).

Total: 45 Hours

Reference(s)

1. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Stephen Marsland, Machine Learning- An Algorithmic Perspective, Chapman and Hall, CRC Press, Second Edition, 2014.
3. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Third Edition, 2014.
4. Christopher Bishop, Pattern Recognition and Machine Learning Springer, 2007.
5. P. Flach, Machine Learning: The art and science of algorithms that make sense of data, Cambridge University Press, 2012.

21AU015 COMPUTER AIDED DESIGN AND MANUFACTURING 3 0 0 3

Course Objectives

- To acquire knowledge on product design and apply them in practice
- To develop the new products with new technologies as per the industrial standards.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Demonstrate the parameters applied for new product development.
2. Enumerate the process of design requirement for product modeling.
3. Apply the industrial standards for product models produced using modeling software's.
4. Demonstrate the various requirements of CNC machine and its applications.
5. Implement recent technologies for developing a new product.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2		2	1	1	1	1			1	2	1	
2	1	2		2	2		1	1			1	1	1	
3	2	1		1		2	2	2			2	2	1	
4	3	2		2			2	2			2	2	3	
5	1	2		2		3	1	1			1		1	

UNIT I **9 Hours**

INTRODUCTION

Product cycle- Design process- sequential and concurrent engineering- Computer aided design - CAD system architecture- Computer graphics- co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation-Brief introduction to CAD and CAM - Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts - Types of production - Manufacturing models and Metrics - Mathematical models of Production Performance.

UNIT II **9 Hours**

GEOMETRIC MODELING

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling — surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep

UNIT III **9 Hours**

CAD STANDARDS

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

UNIT IV **9 Hours**

FUNDAMENTAL OF CNC AND PART PROGRAMING

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- Introduction of CAM package.

UNIT V **9 Hours**

CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS)

Group Technology (GT),Part Families-Parts Classification and coding-Simple Problems in Opitz Part Coding system-Production flow Analysis-Cellular Manufacturing-Composite part concept-Types of Flexibility - FMS - FMS Components - FMS Application & Benefits - FMS Planning and Control - Quantitative analysis in FMS ME8691 Computer Aided Design and Manufacturing

Total: 45 Hours

Reference(s)

1. "CAD/CAM" Ibrahim Zeid Tata McGraw Hill.
2. Principles of Computer Integrated Manufacturing S.Kant Vajpayee , Prentice Hall of India, New Delhi. 1999
3. Work Systems And The Methods, Measurement And Management of Work Groover M. P.,Pearson Prentice Hall Upper Saddle River, NJ, 2007.
4. Computer Automation in Manufacturing Boucher, T. O., Chapman & Hall London, UK, 1996.
5. Introduction to Robotics: Mechanics And Control Craig, J. J. Addison-Wesley Publishing Company 2nd Ed 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition Nicolas Windpassinger Amazon.
7. Internet of Things: A Hands-on Approach" ArshdeepBahga and Vijay Madisetti Universities Press
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker 2nd Ed. (2015)
9. Understanding Additive Manufacturing Andreas Gebhardt, Hanser Publishers 2011
10. Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011

21AU016 COMPUTATIONAL AERODYNAMICS 3 0 0 3

Course Objectives

- To implement the new technologies for real time applications with aerodynamic concepts.
- To develop the skills required for analysis the dynamic behavior of a vehicle.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyze the requirements of CFD in modern automobiles.
2. Analyze the behavior of partial differential equations in aerodynamics.
3. Demonstrate the various functions of Discretization and its applications.
4. Apply the various techniques associated with the aerodynamics.
5. Demonstrate the finite volume method with various techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2
1	1	2	2	3		1	1	1		1	1	1	1	
2	1	2	1	2		2	2	1		2	1	2	1	
3	2	1	1	1		1	1	1		1	2	1	1	
4	3	2	1	1		2		2		1	1	1	3	
5	1	2	2	2		1	1	1		3	2	1	1	

UNIT I **9 Hours**

INTRODUCTION TO COMPUTATIONAL AERODYNAMICS

Need of computational fluid dynamics, philosophy of CFD, CFD as a research tool as a design tool, applications in various branches of engineering, models of fluid flow finite control volume, infinitesimal fluid element, substantial derivative physical meaning of divergence of velocity, derivation of continuity, momentum and energy equations, physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications strong and weak conservation forms shock capturing and shock fitting approaches.

UNIT II **9 Hours**

MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR IMPACT ON COMPUTATIONAL AERODYNAMICS

Classification of quasi-linear partial differential equations by Cramer's rule and Eigen value method, general behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations: domain of dependence and range of influence for hyperbolic equations, well-posed problems.

UNIT III **9 Hours**

BASIC ASPECTS OF DISCRETIZATION

Introduction to finite difference: finite difference approximation for first order, second order and mixed derivatives, explicit and implicit approaches, truncation and round-off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions. Von Neumann stability analysis, physical significance of CFL stability condition. Need for grid generation, structured grids artesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, C-mesh, O-mesh, I-mesh, multi-block grids, C-H mesh, H-O-H mesh, oversetgrids, adaptive grids, unstructured grids: triangular, tetrahedral cells, hybrid grids, quadrilateral, hexahedral cells.

UNIT IV **9 Hours**

CFD TECHNIQUES

Lax-Wendroff technique, MacCormack's technique, Crank Nicholson technique, Relaxation technique, aspects of numerical dissipation and dispersion. Alternating-Direction-Implicit (ADI) Technique, pressure correction technique: application to incompressible viscous flow, need for staggered grid. Philosophy of pressure correction method, pressure correction formula. Numerical procedures: SIMPLE, SIMPLER, SIMPLEC and PISO algorithms, boundary conditions for the pressure correction method.

UNIT V **9 Hours**

FINITE VOLUME METHODS

Basis of finite volume method, conditions on the finite volume selections, cell-centered and cell vertex approaches. Definition of finite volume discretization, general formulation of a numerical scheme, two dimensional finite volume method with example.

Total: 45 Hours

Reference(s)

1. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid
2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", Engineering Education Systems, 4th Edition, 2000.
3. Patankar, S.V., "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. Corporation, 1st Edition, 1980.

21AU017 FINITE ELEMENT ANALYSIS 3 1 0 3

Course Objectives

1. To impart basic knowledge in finite element method.
2. To deliver knowledge in 1D elements.
3. To provide knowledge in 2D elements.
4. To practice approaching heat conduction problems using finite element method.
5. To provide knowledge in higher order and iso-parametric elements.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Apply the numerical methods to formulate the simple finite element problems.
2. Develop one dimensional finite element method to solve bar, beam and truss type problems.
3. Appraise finite element method for plane stress, plane strain and axisymmetric conditions.
4. Evaluate temperature distribution of one- and two-dimensional heat transfer problems using oneand two dimensional finite elements.
5. Analyse the numerical methods to formulate the higher order and isoperimetric problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1										3	
2	2	1	1										3	
3	2	3	1										3	
4	2	3	1										3	
5	3	2	2										3	

UNIT I **10 Hours**

INTRODUCTION

Relevance and scope of finite element methods - strain vs displacement relations - stresses and equilibrium - natural and essential boundary conditions - Rayleigh-Ritz - Galerkin method- FEA procedure - Discretisation of domain-element shapes, types, size, location, and numbers.

UNIT II **10 Hours**

ONE-DIMENSIONAL (1D) PROBLEMS

Coordinate systems-global, local and natural.Finite element formulation - shape function, stiffness matrix, load vector and assembly of global equation - 1D bar element and two nodded truss element-problems.Introduction to beam elements.

UNIT III **8 Hours**

TWO-DIMENSIONAL (2D) PROBLEMS

Finite Element Formulation - Shape function for linear triangular element, Constant Strain Triangular (CST) element. Strain vs displacement matrix of CST element, plane stress, plane strain and axisymmetric conditions - problems. Introduction to space frame and planar frame elements.

UNIT IV **9 Hours**

HEAT TRANSFER APPLICATIONS

Formulation of shape function, stiffness matrix, load vector, assembly of global equation - 1D and 2D elements with heat conduction, heat convection and internal heat generation conditions-problems. Introductionto 3D axisymmetric problems.

UNIT V **8 Hours**

HIGHER ORDER ELEMENTS AND ISOPARAMETRIC ELEMENT FORMULATION

Selection of order of polynomial-linear, simplex, complex and multiplex elements, mesh refinement methods and convergence requirements.Iso, Sub and Super parametric element, shape functions for a 2-D four nodded and eight nodded Isoparametric rectangular element using natural coordinate system - problems. Gaussian quadrature method-problems.

Total: 60 Hours

Reference(s)

1. KJ Bathe, Finite Element Procedures, PHI Learning, 2007.
2. Rao S. S., The Finite Element Method in Engineering, Elsevier, 6th Edition, 2017.
3. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering,Pearson Education, 4th Edition 2012.
4. David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Education, 2009.
5. https://nptel.ac.in/courses/112104116/
6. https://nptel.ac.in/courses/112104193/

21AU018 COMPUTER INTEGRATED MANUFACTURING INAUTOMOTIVE SECTOR

3 1 0 3

Course Objectives

- To understand the application of computers in various aspects of Manufacturing viz.,

Programme Outcomes (POs)

d. a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

e. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

f. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Apply the CAM and CAD to formulate the simple production problems.
2. Develop the production planning and control and computerised process planning.
3. Appraise Cellular Manufacturing for group technology.
4. Evaluate flexible manufacturing system (fms) and automated guided vehicle system (agvs).
5. Analyse the industrial robotics problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1										3	
2	2	1	1										3	
3	2	3	1										3	
4	2	3	1										3	
5	3	2	2										3	

UNIT I **8 Hours**

INTRODUCTION

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II **8 Hours**

PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems

UNIT III **8 Hours**

CELLULAR MANUFACTURING

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV **10 Hours**

FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDEDVEHICLE SYSTEM (AGVS)

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planningand Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V **10 Hours**

INDUSTRIAL ROBOTICS

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems..

Total: 60 Hours

Reference(s)

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008..
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000
3. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
4. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India.
5. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.

21AU019 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER **3 1 0 3**

Course Objectives

- The course offers introductory concepts about solving PDE mainly in the finite difference(FD) framework though some amount of finite volume (FV) concept has also beenintroduced.
- The primary objective of the course is to teach fundamentals of computational method forsolving linear and non-linear partial differential equations (PDE).

Programme Outcomes (POs)

g. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

h. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

i. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Apply the Initial and Boundary conditions to formulate the simple finite difference equations.
2. Develop aspects of fde and solution of simultaneous equations.
3. Analyse the Errors and Stability of FDE.
4. Evaluate FDE in other coordinate systems and FVM.
5. Analyse the Stream function-vorticity approach and Primitive variable approach.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1										3	
2	2	1	1										3	
3	2	3	1										3	
4	2	3	1										3	
5	3	2	2										3	

UNIT I **8 Hours**

INTRODUCTION AND FDM

Brief introduction of ODE (IVP and BVP) and PDE, Initial and Boundary conditions, classification of PDE, various methods to solve PDE numerically along with their advantages and disadvantages, FDM: Taylor series expansion, Finite difference equations (FDE) of 1st, and 2nd order derivatives, Truncation errors, order of accuracy. Application of FDM: Steady and unsteady one- and two-dimensional heat conduction equations, one-dimensional wave equations, General method to construct FDE

UNIT II **8 Hours**

ASPECTS OF FDE AND SOLUTION OF SIMULTANEOUS EQUATIONS

Convergence, consistency, explicit, implicit and C-N methods. Solution of simultaneous equations: direct and iterative methods; Jacobi and various Gauss-Seidel methods (PSOR, LSOR and ADI), Gauss-elimination, TDMA (Thomas), Gauss-Jordan, other direct and indirect methods

UNIT III **8 Hours**

Errors and Stability of FDE

Diffusion and dispersion errors Stability of 1D and 2D diffusion equation, 1D wave equation (FTCS, FTBS and FTFS). Modified equations of FD formulation: Diffusion and dispersion errors of modified equation (wave equation) having second and third order derivatives, modified wave number and modified speed.

UNIT IV **10 Hours**

Upwinding, FDE in other coordinate systems and FVM

Upwinding: Upwinding of convective terms and its significance, Transportiveand conservative properties.Upwind biased difference schemes and its significance. FDE in other coordinate systems: Cylindrical and polar coordinate systems, FVM: Two approaches of generating Cartesian grids, Solution of fin problem in FVM, Handling of BCs in FVM; Generalized FVM approach for orthogonal grids (complex geometry).

UNIT V **10 Hours**

Stream function-vorticity approach and Primitive variable approach

Stream function-vorticity approach: Derivation of stream function and vorticity equations; derivation pressure Poisson equation. Application 2-3 problems. Primitive variable approach: Grid system (Staggered vs collocated grids); their advantages and disadvantages; control volumes for continuity and N-S equations. MAC method; derivation of pressure correction equations; discretization of GDE and BCs for channel flow; solution algorithm; stability constraints. Projection/Fractional step method; solution algorithm; difference with MAC. SIMPLE and SIMPLER method (FVM): derivation of pressure and pressure-correction and velocity correction equations. Discretization and solution algorithm.

Total: 60 Hours

Reference(s)

1. Computational Fluid Flow and Heat Transfer, Second Editionby K. Muralidhar, T. Sundararajan(Narosa), 2011.
2. Computer Simulation of Flow and Heat TransferbyP. S. Ghoshdastidar (4th Edition, TataMcGraw-Hill), 1998.
3. Numerical Computation of Internal and External Flowsby Hirch C., Elesvier2007.
4. Numerical Heat Transfer and Fluid FlowbyS. V. Patankar(Hemisphere Series on ComputationalMethods in Mechanics and Thermal Science)
5. Essential Computational Fluid Dynamicsby Zikanov.O., Wiley 2010.
6. Computational Fluid Dynamics byChung T. J., Cambridge University Press, 2003

21AU020 INDUSTRY 4.0 **3 0 0 3**

Course Objectives

- To understand the advantages compared to conventional production techniques
- To learn about how intelligent processes, big data, and artificial intelligence can be used to build up the production of the future.
- To understand basics, drivers and enablers of Industry 4.0.
- To apply modern methods and techniques of planning, dimensioning, design and optimization of Industry 4.0 production systems
- To learn about value chains in Industry.

Programme Outcomes (POs)

a. Apply the fundamental knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, automotive engines, automotive mechanics, automotive electrical system, thermodynamics, material and manufacturing sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations with the knowledge of vehicle body engineering, design of automotive chassis components, automotive emission and control and design of automotive engine components.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

n. Use concepts, theories and principles of science, mathematics and information technology to develop intelligent vehicle systems and embedded systems for automotive applications.

o. Apply the broad knowledge and understanding of the concepts, theories and principles of automotive engineering to investigate emerging technologies and applications in the Automotive field

Course Outcomes (COs)

1. Understand basics, drivers and enablers of Industry 4.0
2. Analyze the elements of modern methods and techniques of planning, dimensioning.
3. Design and optimization of Industry 4.0 production systems.
4. Implement value chains in Industry.
5. Implement smart factory paradigm.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2				2									2	
2	2		3		3									2	2
3	3	2			3									2	2
4	3	2	3		3									2	
5	3	3	3		3									2	

UNIT I **9 Hours**

INTRODUCTION TO INDUSTRY 4.0

Definition of Industry 4.0, Developments in USA, Europe, China and other countries, Comparisonof Industry 4.0 Factory and today's Factory, The 10 most important things
that will change with Industry 4.0, Difference between conventional automation and Industry 4.0.

UNIT II **9 Hours**

BASIC PRINCIPLES AND TECHNOLOGIES OF A SMART FACTORY

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Big Data, Cyber-Physical Systems, value chains in manufacturing companies,
Customization of products, Digital Twins, Cloud Computing / Cloud Manufacturing, Security issues within Industry 4.0 networks.

UNIT III **9 Hours**

THE SMART WORKPIECE

The intelligent work piece as basic functionality in implementing Industry 4.0, intelligent
workpiece, Work piece tagging, QR codes and RFID, Communication between work piece and environment, Multi- agent systems in production, Applicationsfor smart work pieces'

UNIT IV **9 Hours**

DIGITAL TWINS IN PRODUCTION

Basic concepts of Digital Twins, Benefits, impact and challenges, Features and
Implementation of Digital Twins, Types of Digital Twins, Digital Twin use cases, Applications for digital twins in production.

UNIT V **9 Hours**

ASSISTANCE SYSTEMS FOR PRODUCTION

The connected worker within the Industry 4.0 scenario, Diversity-driven workplaces (barrier free workplaces, accessibility in production), Human-and task-centered assistance systems (e.g. motioncapture system for training employees, etc.), Technical
tools ("Ambient Assisted Working" (AAW)), Mobile information technologies, Shop floor information systems, Production line support systems (pick by light, assembly display systems, assembly control by vision, …), Manipulator systems and intelligent
chairs, Human work support by using exoskeletons, Applications assistance systems in production.

Total: 45 Hours

Reference(s)

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

2. ArshdeepBahga, Vijay Madisetti, Internet of Things-A hands-on approach, UniversitiesPress, 2015

3. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things- Key applications and Protocols, Wiley, 2012

4. Jan Holler, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence, Elsevier, 2014.

5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Architecting the Internetof Things, Springer, 2011

21AU021 ADVANCED AUTOMOTIVE MATERIALS 3 0 0 3

Course Objectives

- To understand the future trends in body materials.
- To study the use and significance of carbon polymers.
- To study the properties on polymers and its application in automotives.

Programme Outcomes (POs)
Course Outcomes (COs)

1. To understand the basic knowledge and use of advanced materials and composites in automotive engineering
2. Recommend suitable manufacturing process to produce a component
3. Evaluate and match materials and manufacturing processes
4. Evaluate and arrive at material properties for automotive components and select appropriate materials
5. Evaluate the cause for failure of the components due to material or manufacturing process and recommend the appropriate remedy to avoid the failure

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	1	2	1	2			1	2	1		
2	2	1	2	1	2	1	1			2	2	1		
3	2	1	3	1	2	1	2			1	2	1		
4	2	1	1	1	2	1	3			2	2	1		
5	2	1	1	1	2	1	1			3	3	1		

UNIT I **6 Hours**

Introduction to Advanced Materials

Composites and hybrids Sandwich materials, Metal matrix composites: automotive applications. Ceramic and glasses, automotive glazing, sustainable materials. Advanced composites.

UNIT II **6 Hours**

Polymers

Processing of polymers, components for noise and vibration isolation and control on automotive industry. Recycling of polymers, biopolymers, and steel processing: formability of steel sheets and tailor welded blanks for automotive application. Thermoplastics, thermosets.

UNIT III **6 Hours**

Carbon Fibers

Carbon-fibers-reinforced silicon carbide. Magnesium: Properties and automotive application for magnesium. New brake disc material - Elements of ceramic brake disc, material behaviour, material properties, advantages. Titanium and Nickel: Properties and their automotive applications.

UNIT IV **6 Hours**

Body Materials

Future trends in body materials; objectives and contents. Mechanical and physical properties of materials. Material selection for automotive body components. Trimming of plastics. Insulating materials and sealing compounds. Factors influencing material change in future, emission control and fuel systems.

UNIT V **6 Hours**

Futuristic technology and material for automotive applications

Designing hybrid materials- material for auto piloting, manufacturing considerations for various lightweight automotive structures, 3D printing-materials, processes and applications. Case studies on Li-ion battery, polymer composites and sensor materials.

Total: 30 Hours

Reference(s)

1. Michel F Ashby, "Material Selection in Mechanical Design", Butterworth Heinemann, 2007.
2. Michel F Ashby, "Material and Design: The Art and Science of Material Selection in Product Design", Butterworth Heinemann, 2008.
3. John Mortimer, "Advanced Manufacturing in the Automotive Industry" Springer, 1997.
4. Harry Peck, "Design for Manufacturing", Pitman Publications, 1983.
5. Cantor B, Johnston, Colin Grant and Patrick, "Automotive Engineering: Lightweight, Functional and Novel Materials", Taylor & Francis Ltd, 2008.

21AU022 NOISE, VIBRATION AND HARSHNESS 3 0 0 3

Course Objectives

- To acquire knowledge on sources of noise, vibration and harshness
- To Understand the effect of noise on human comfort and environment
- To explain measurement techniques and control techniques of vibration and noise

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g. Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.
h. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Explain the basic concept of vibration, sources of vibration and noises in automobiles
2. Analyse the effect of noise and vibration on human beings and nature
3. Analyse the various methods to predict and control the noise and vibration in different components of automobiles.
4. Find out the suitable transducers to reduce the noise and vibration in automobiles
5. Explain the different NVH controlling techniques in an interior transportation and safety precautions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3					2	3							2
2						2	3							2
3		2				2	3							2
4		1				2	3							2
5	3	2				2	3							2

UNIT I **9 Hours**

INTRODUCTION TO NOISE, VIBRATION AND HARSHNESS

Definition of Noise, Vibrations & Harshness in reference to Vehicular application - Noise - Definition, basic attributes of sound and units (wavelength, period, frequency velocity, speed, pressure, power and sound intensity - sound wave -properties, sound sources, sound propagation in the atmosphere, sound radiation from Structures - General Introduction to Vibration, free and forced vibration, undamped and damped vibration, linear and non linear vibration.

UNITII **9 Hours**

EFFECTS OF NOISE AND VIBRATION ON PEOPLE

Effects on people and hearing conservation, sleep disturbance due to transportation noise exposure, noise-induced annoyance, effects of infrasound, low-frequency noise and ultrasound on people, auditory hazards of impulse and impact noise, effects of intense noise on people and hearing loss, effects of vibration on people, rating measures, and procedures for determining human response to noise and vibration.

UNITIII **9 Hours**

TRANSPORTATION NOISE AND VIBRATION A SOURCES AND CONTROL

Internal Combustion Engine Noise - Prediction and Control, Diesel exhaust and intake noise and acoustical design of mufflers - Tire/Road Noise - Generation, Measurement, and Abatement - Aerodynamic Sound Sources in Vehicles - Prediction and Control, Transmission, Gearbox Noise, Vibration, prediction and control, Brake Noise Prediction and Control.

UNITIV **9 Hours**

TRANSDUCERS AND MEASUREMENT TECHNIQUES

Transducers and exciters - Sound pressure, intensity and power measurement. Sound level meters, noise dosimeters, analyzers and signal generators, equipment for data acquisition and digital signal processing - Calibration of measurement microphones, calibration of shock and vibration transducers, metrology and traceability of vibration and shock measurements.

UNITV **9 Hours**

NOISE AND VIBRATION IN INTERIOR TRANSPORTATION AND SAFETY

Interior Transportation Noise and Vibration - Introduction - Automobile, Bus, and Truck Interior Noise and Vibration Prediction and Control, Noise and Vibration in Off-Road Vehicle Interiors-Prediction and Control - Study of NVH - Legislations applicable for vehicles in India-Safety - Passive safety Active safety.Study of Safety Regulations for vehicular application

Total: 45 Hours

Reference(s)

1. David A.Bies and Colin H.Hansen, Engineering Noise Control: Theory and Practice, Spon Press, London, 2009
2. Xu Wang, Vehicle Noise and Vibration Refinement, Sawston, Cambridge: Woodhead Publishing Ltd, 2010.
3. M.Harrison, Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Oxford: Butterworth-Heinemann Elsevier Ltd, 2004.
4. C.W. de Silva, Vibration Monitoring, Testing, and Instrumentation, Boca Raton: CRC Press, 2007.

21AU023 ROAD VEHICLE AERODYNAMICS 3 0 0 3

Course Objectives

- To acquire knowledge on sources of noise, vibration and harshness
- To Understand the effect of noise on human comfort and environment
- To explain measurement techniques and control techniques of vibration and noise

Programme Outcomes (POs)

c. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

d. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

i. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

j. Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.

k. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (Cos)

1. Knowledge upon the forces & moments influencing drag.
2. Solve exercises related to fuel economy & drag.
3. Appraise upon the techniques of shape-based optimization practiced in industry.
4. Awareness about the influence of rider position in motorcycle aerodynamics.
5. Expose to fundamentals of Experimental testing.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3					2	3							2
2						2	3							2
3		2				2	3							2
4		1				2	3							2
5	3	2				2	3							2

UNIT I

Scope of Road Vehicle Aerodynamics **9 Hours**

Introduction, Properties of Incompressible Fluids, External Flow Phenomena Related to Vehicles, Aerodynamic Forces and Moments, Resistances to Vehicle Motion, Performance, Fuel Consumption and Fuel Economy, Strategy for Lowest Fuel Consumption.

UNIT II

Air Resistance on Passenger Cars **9 Hours**

Car as a Bluff Body, Drag and Lift, Drag Fractions and Their Local Origins - Front End, Windshield and A-Pillar, Roof, Rear End, Plan View and Side Panels, Underbody, Wheels and Wheel Housings, Front Spoiler, Rear Spoiler. Strategies for Body Shape Development – Objectives, Detail Optimization, Shape Optimization, Facelift, Spoilers.

UNIT III

Aerodynamic Drag on Commercial Vehicles **9 Hours**

Relation between Tractive Resistance, Drag Reduction and Fuel Consumption, Aerodynamic Drag Coefficients of Various Commercial Vehicles, Drag Minimization on Trucks, Buses. Add-on devices for drag reduction. Reduction of Vehicle Soiling, Water accumulation on windshield and windows.

UNIT IV

MOTORCYCLE AERODYNAMICS **9 Hours**

Development of Motorcycle Aerodynamics, Riding Dynamics and its Relationship with Aerodynamics, Methods of Measurement in Road Tests, Rider Influences - Rider and Pillion Passenger, Clothing and Helmets. Case Studies on racing models.

UNIT V

Wind Tunnels, Measurement and Test Techniques **9 Hours**

Fundamentals of Wind Tunnel Technique, Tests with Reduced-Scale Models - Details of Model Construction and Test Technique, Reynolds Number Effects, Climatic Tunnels. Measuring Equipment and Transducers – Flow visualization techniques, Measurement of Aerodynamic Forces and Moments, Pressure Measurements, Measurement of the Airflow Velocity, Temperature Measurement.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Alan Pope, Jewel B. Barlow, William H. Rae "Low speed wind tunnel testing", John Wiley & Sons, Third edition, 1999
2. Hucho. W.H. – "Aerodynamic of Road Vehicles – From Fluid Mechanics to Vehicle Engineering", Society of Automotive Engineers, U.S, Fourth edition, 1998

REFERENCES:

1. R.H.Barnard - "Road vehicle aerodynamic design, An Introduction" , Mechaero publications, Third edition, 2010
2. T. Yomi Obidi - "Theory and Applications of Aerodynamics for Ground Vehicles" , SAE International, 2014

21AU024 ALTERNATE FUELS AND ENERGY SYSTEMS

3 0 0 3

Course Objectives

- To evaluate the potentials of various alternative fuels for I.C. engines operation
- To develop understanding on production methods of alternative fuels
- To acquire knowledge on principles of electric, hybrid and fuel cell powered vehicles

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
5. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyze the Performance, emission and combustion characteristics of alcohol used in CI and SI engines.
2. Compare the properties of various vegetable oil and explain the performance emission and combustion characteristics
3. Compare the different method of using hydrogen as a fuel in SI and CIengines
4. Analyze Performance and emission characteristics of biogas, NG and LPG in SI and CIengines.
5. Analyze the principle, construction, and limitations of electric, hybrid and fuel cellpowered vehicle

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2				2						2	
2	3	2	2				2						3	
3	3	3	1				2						3	
4	2	3	2				2						3	
5	2	2	2				2						3	

UNIT I **10 Hours**

Alcohols as Fuels

Introduction - need for alternative fuels, availability of different alternative fuels for SI and CI engines, Alcohols as fuels- properties of alcohols as fuels, Production methods of alcohols, Methods of using alcohols in CI and SI engines- blending, dual fuel operation, surface ignition and oxygenated additives, Performance emission and combustion characteristics in CI and SI engines.

UNIT II **9 Hours**

Vegetable Oils as Fuels

Various vegetable oils and their important properties, property enhancing methods- Methods of using vegetable oils in engines - blending, preheating , Esterification, Transesterification and emulsification of vegetable oils, Performance in engines -performance, emission and combustion characteristics.

UNIT III **9 Hours**

Hydrogen as Engine Fuel

Properties of hydrogen - Production methods of hydrogen, Combustive properties of hydrogen, Problems associated with hydrogen as fuel and solutions, Different methods of using hydrogen in SI and CI engines- performance, emission and combustion analysis, Hydrogen storage - safety aspects of hydrogen.

UNIT IV **9 Hours**

Biogas, Natural Gas And Lpg As Fuels

Production methods of Biogas- natural gas and LPG, properties, CO2 and H2S scrubbing in biogas, Modification required to use in SI and CI Engines, Performance and emission characteristics of biogas, NG and LPG in SI and CI engines.

UNIT V **8 Hours**

Electric, Hybrid and Fuel Cell Vehicles

Layout and principle of electric and hybrid vehicles- advantages and drawbacks of electric and hybrid vehicles, system components, electronic control system, different configurations of hybrid vehicles, Fuel cell electric vehicles- operating principle, fuel cell technologies.

Total: 45 Hours

Reference(s)

1. S.S .Thipse, Alternate Fuels Concepts, Technologies and Dvelopments, Delhi :Jaico Publishing House, 2010.
2. V. Ganesan, Internal Combustion Engines, New Delhi : Tata Mcgraw Hill Publishing Co. Ltd, 2012.
3. L .Mathur, R.P. Sharma, Internal Combustion Engines, New Delhi :DhanpatRai Publications (P), Ltd, 8th edition, 2010.
4. R. L. Bechfold, Alternative Fuels Guide Book, Warrendale : SAE International,1997.
5. Alcohols as motor fuels progress in technology, Series No.19, USA: SAE Publication, 1980.

21AU025 AUTOMOTIVE INSTRUMENTATION AND TESTING

3 0 0 3

Course Objectives:

- To provide theoretical and applicative knowledge in automobile test instrumentation.
- To identify the various instruments for measuring force, torque, pressure, temperature, fluid flow, velocity and rotational speed.
- To enhance the knowledge of students regarding the experimental methods followed in industries.
- To familiarize the students on standard test codes.
- To impart skills on the testing procedure followed for evaluating brake, engine and vehicle.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.
5. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes:

1. The students will be able to
2. Demonstrate the understanding of engine testing procedures.
3. Develop a measurement strategy for temperature, pressure, mass flow, velocity.
4. Understand sensors and instrumentation, and to analyse and interpret test data.
5. Develop new system that would help in keeping the environment sustainable.
6. Demonstrate the understanding of brake testing procedures

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2				2						2	
2	3	2	2				2						3	
3	3	2	1				2						3	
4	2	3	2				2						3	
5	2	2	2				2						3	

UNIT I

Mechanical Measurement **9 Hours**

Introduction to measurements – Construction, principle, working of Instruments for measuring force, torque, pressure, temperature, fluid flow, velocity, rotational speed.

UNIT II

Vibration and Body Test **9 Hours**

Vibration measurement instrument – accelerometer and signal conditioning. Dynamic simulation sled testing, methodology, vehicle acceleration measurement and documentation. Dolly roll over test, dolly role over fixture, photographic / video coverage. Vehicle roof strength test –. Door system crush test – wind tunnel tests.

UNIT III

Crash and Brake Test **9 Hours**

Crash tests –standards – road hazard impact test for wheel and tire assemblies, test procedures, failure and performance criteria. Bumpers - types of tests, pendulum test, and fixed collision barrier test, procedure, performance criteria. Air and hydraulic brake test, air brake actuator, valves test, performance requirements.

UNIT IV

Engine Experimental Techniques **9 Hours**

I.S Code for Engine testing – Instruments for performance testing of engine, Instrumentation for measuring noise, vibration in cylinder, different types of engine tests are performed within the industry.

UNIT V

Vehicle Experimental Techniques **9 Hours**

Laboratory tests- test tracks - Endurance Tests - Dynamic cornering fatigue, dynamic radial fatigue tests – procedure, bending moment and radial load calculations.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Crouse W H and Anglin D L., “Automotive Mechanics”’ Tata McGraw Hill Publishing Company, 2004.
2. J.G .Giles, Vehicle Operation & Testing. Volume 7 of Automotive technology series, Iliffe,1969
3. Richard D. Atkins, “An Introduction to Engine Testing and Development”, SAE International 2009.

REFERENCES:

1. Beckwith TG and Buck N L, “Mechanical Measurements”, Addition Wesley Publishing Company Limited, 1995.
2. Jain R K “Mechanical and Industrial Measurements”, Khanna Publishers, Delhi, 1999.
3. Stockel M W, “Auto Mechanics Fundamentals”, Good Heart-Wilcox Co., Inc., 2000.

21AU026 IC ENGINE PROCESS MODELING 3 0 0 3

Course Objectives:

- To impart knowledge on simulation of IC engine components.
- To understand the principle behind the stoichiometric ratio and adiabatic flame temperature.
- To develop a model on simulation of SI engine models.
- To understand the concept of gas exchange process in SI engine.
- To impart knowledge on simulation of CI engine.

Programme Outcomes (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Understand the impact of the professional engineering solutions in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.
5. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes:

1. To impart knowledge in modeling the Internal combustion engine processes and acquire knowledge in different types of engine models and their importance
2. To understand the calculation of heat of reaction, air fuel ratio and flame temperature for developing a thermodynamic engine model.
3. To acquire knowledge on the detailed concept of air standard, fuel air cycle, progressive and actual cycle simulation of SI engine.
4. To understand the gas exchange process and develop models for the intake and exhaust processes.
5. To develop a complete theoretical engine model for the SI engine and differentiate the model from CI engine model.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1				2						2	
2	3	2	2				2						3	
3	3	1	2				2						3	
4	2	3	1				2						3	
5	2	2	2				2						3	

UNIT I

Introduction to Simulation **9 Hours**

Introduction to Simulation, Advantages of computer simulation, Classification of engine models. Intake and exhaust flow models – Quasi steady flow -Filling and emptying -Gas dynamic Models. Thermodynamic based in cylinder models. Step by step approach in SI engine simulation. Overview of modeling softwares.

Unit II

Stoichiometry and Adiabatic Flame Temperature **9 Hours**

Reactive processes, Heat of reaction, measurement of URP, measurement of HRP. Introduction - combustion equation for hydrocarbon fuels. Calculation of minimum air, excess air and stoichiometric air required for combustion. Introduction, complete combustion in C-H-N-O systems, constant volume adiabatic combustion, constant pressure adiabatic combustion, calculation of adiabatic flame temperature, isentropic changes of state.

UNIT III

Si Engine Simulation **9 Hours**

SI Engine simulation with air as working medium, deviation between actual and ideal cycle. Fuel air cycle analysis - Temperature drop due to fuel vaporization, full throttle operation, work output and efficiency calculation, part-throttle operation, engine performance at part throttle, super charged operation. SI Engines simulation with progressive combustion. Models for mass burnt fraction.

UNIT IV

SI Engine Simulation with Gas Exchange Process **9 Hours**

Introduction, gas exchange process, Heat transfer process, friction calculations, comparison of simulated values, validation of the computer code, engine performance simulation, pressure crank angle diagram, brake power, brake thermal efficiency, effect of speed on performance and analysis of the data.

UNIT V

Engine Simulation for Ci and Advanced Engines **9 Hours**

Zero, one and multizone models for diesel engine combustion. Wiebe's Model, Whitehouse model and Watson model for diesel combustion. Heat release rate and heat transfer models. Equilibrium calculations. Engine modeling for dual fuel engine- Multifuel engines. Programming of the modeling process and validation of the models. Parametric studies on simulated engine performance.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ganesan.V. "Computer Simulation of spark ignition engine process", Universities Press (I) Ltd, Hyderbad, 1996.

REFERENCES:

1. Ashley Campbel, "Thermodynamic analysis of combustion engines", John Wiley & Sons, New York, 1986.
2. Benson.R.S., Whitehouse.N.D., "Internal Combustion Engines", Pergamon Press, oxford, 1979
3. John. B. Heywood, 'Internal Combustion Engines'", Tata McGraw Hill Co., Newyork, 1988.
4. Ramoss.A.L., "Modelling of Internal Combustion Engines Processes", McGraw Hill Publishing Co., 1992.

21AU027 AGRICULTURAL VEHICLES 3 0 0 3

Course Objectives

- To acquire knowledge on agricultural vehicles and apply them in practice
- To develop understanding of the fundamentals of agricultural vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyze the parameters required for new product development.
2. Analyze the design requirement for new product development
3. Demonstrate product models produced using prototyping machines
4. Explain the various costs associated with the new product development
5. Implement recent advancements in product design.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2											1	
2	1	2											1	
3	2	1											1	
4	3	2											3	
5	1	2											1	

UNIT I **9 Hours**

TRACTORS

Classification of tractors - Tractor engines – construction of engine blocks, cylinder head and crankcase - features of cylinder, piston, connecting rod and crankshaft – firing order combustion chambers.

UNIT II **9 Hours**

PRIMARY AND SECONDARY TILLAGE IMPLEMENTS

Mould board plough- attachments – mould board shapes and types. Disc plough – force representation on disc – Types of disc ploughs – Subsoiler plough – Rotary plough. Cultivators -types – construction. Disc harrows – Bund former – ridger – leveller. Basin lister-Wetland preparation implements.

UNIT III **9 Hours**

POWER TILLER, BULLDOZER

Power tiller - special features - clutch - gear box - steering and brake. Makes of tractors, power tillers and bulldozers. Bulldozer- salient features – turning mechanism, track mechanism, components – operations performed by bulldozers.

UNIT IV **9 Hours**

HARVESTING MACHINERY

Principles of cutting crop, types of harvesting machinery, vertical conveyor reaper and binder combine harvesters, balers, threshers, tractor on top combine harvester, combine losses.

UNIT V **9 Hours**

TRACTOR TESTING

Types of tests- test procedure - need for testing & evaluation of farm tractor -Test code for performance testing of tractors and power tillers.

Total: 45 Hours

Reference(s)

1. Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 6.,2010.
2. Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005
3. Kepner, R.A., et al. Principles of farm machinery. CBS Publishers and Distributers, Delhi.99, 2008.
4. Harris Pearson Smith et al. Farm machinery and equipment. Tata McGraw-Hill pub., NewDelhi.,2003
5. Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 2005.

21AU028 DEFENCE VEHICLES **3 0 0 3**

Course Objectives

- To acquire knowledge on Defence vehicles and apply them in practice
- To develop understanding of the fundamentals of Defence vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Analyze the parameters required for military land vehicles.
2. Analyze the design requirement for combat vehicle design
3. Demonstrate product models of combat vehicle engine
4. Explain the various types associated with the logistic vehicle design
5. Implement recent advancements in terramechanics and mobility.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2											1	
2	1	2											1	
3	2	1											1	
4	3	2											3	
5	1	2											1	

UNIT I **9 Hours**

INTRODUCTION TO MILITARY LAND VEHICLES

Historical overview of military vehicle development - The operational environment - Cardinal design requirements - Obstacles- Vehicle geometry - Mass model - Key components - Constraints on mobility.

UNIT II **9 Hours**

COMBAT VEHICLE DESIGN

The operational environment - Cardinal design requirements - Design spiral - Design balance - Critical dimensions - Weight and volume considerations - Configurations - Survivability - Availability - NBC Systems.

UNIT III **9 Hours**

ENGINES TECHNOLOGY

Key performance parameters – Fuels - Spark ignition engines - Military diesel engines - Military power packs - Boosting performance - Ground gas turbines - Future technology trends.

UNIT IV **9 Hours**

LOGISTIC VEHICLE DESIGN

Design requirements - Cab designs - Chassis designs - Load sharing suspensions - Towing issues - Trailer issues - Tray designs - ILHS designs - Flatracks - Tractor designs - Recovery vehicle designs

UNIT V **9 Hours**

TERRAMECHANICS AND MOBILITY

Vehicle Mobility - Mobility Classifications - Vehicle Cone Index - Rated Cone Index - Nominal Ground Pressure - Mean Maximum Ground Pressure - Empirical methods - Parametric methods - NATO Reference Mobility Model -Tyres vs Tracks - Maximizing track vehicle mobility.

Total: 45 Hours

Reference(s)

1. Nunney. Light And Heavy Vehicle Technology Publisher Elsevier., Delhi 6.,2010.
2. Bon-nick Allan et. Al. Practical approach to motor vehicle engineering and maintenance. Yesdee, New Delhi., 2005
3. Trelleborg et al. Automotive Vibration Control Technology: Fundamentals, Materials, Construction, Simulation, and Applications., Delhi.99, 2008.
4. Yacov Bar-Shlomo et al. An Introduction to Weapons Systems. : Create Space Independent Publishing Platform, 2003.
5. Ian Nicholson, Heavy Vehicle Mechanics. McGraw-Hill Education – Europe, 2005.

21AU029 CONSTRUCTIONS VEHICLES 3 0 0 3

Course Objectives

- To acquire knowledge on Constructions Vehicles and apply them in practice
- To develop understanding of the fundamentals of Constructions Vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Develop knowledge on planning of equipment and selection of equipment.
2. Explain the knowledge on fundamentals of earth work operations, earth moving operations and types of earth work equipment
3. Develop the knowledge on special construction equipments
4. Apply the knowledge on asphalt and concrete plants
5. Apply the knowledge and select the proper materials handling equipment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2											1	
2	1	2											1	
3	2	1											1	
4	3	2											3	
5	1	2											1	

UNIT I **9 Hours**

CONSTRUCTION EQUIPMENT SELECTION

Identification – Planning of equipment – Selection of Equipment - Equipment Management in Projects - Maintenance Management – Equipment cost – Operating cost – Cost Control of Equipment - Depreciation Analysis – Replacement of Equipment- Replacement Analysis - Safety Management.

UNIT II **9 Hours**

EQUIPMENT FOR EARTHWORK

Fundamentals of Earth Work Operations - Earth Moving Operations - Types of Earth Work Equipment - Tractors, Motor Graders, Scrapers, Front end Waders – Dozer, Excavators, Rippers, Loaders, trucks and hauling equipment, Compacting Equipment, Finishing equipment.

UNIT III **9 Hours**

CONSTRUCTION EQUIPMENTS

Equipment for Dredging, Trenching, Drag line and clamshells, Tunneling – Equipment for Drilling and Blasting - Pile driving Equipment - Erection Equipment - Crane, Mobile crane - Types of pumps used in Construction - Equipment for Dewatering and Grouting – Equipment for Demolition.

UNIT IV **9 Hours**

ASPHALT AND CONCRETING EQUIPMENTS

Aggregate production- Different Crushers – Feeders - Screening Equipment - Handling Equipment - Batching and Mixing Equipment - Pumping Equipment – Ready mix concrete equipment, Concrete pouring equipment. Asphalt Plant, Asphalt Pavers, Asphalt compacting Equipment.

UNIT V **9 Hours**

MATERIALS HANDLING EQUIPMENT

Forklifts and related equipment - Portable Material Bins – Material Handling Conveyors – Material Handling Cranes- Industrial Trucks.

Total: 45 Hours

Reference(s)

1. Peurifoy, R.L., Schexnayder, C. and AviadShapira., Construction Planning, Equipment and Methods, McGraw Hill, Singapore, 2010.
2. Granberg G.,Popescu M Construction Equipment and Management for Engineers Estimators and Owners, Taylor and Francis Publishers, New York, 2006.
3. Deodhar, S.V. Construction Equipment and Job Planning, Khanna Publishers, New Delhi, 2001.
4. Arora S.P. and Bindra S.P., Building Construction, Planning Techniques and Method of Construction, DhanpatRai and Sons, 2010.
5. Sharma S.C. Construction Equipment and Management, Khanna Publishers, New Delhi, 2008.

21AU030 MARINE VEHICLES 3 0 0 3

Course Objectives

- To acquire knowledge on agricultural vehicles and apply them in practice
- To develop understanding of the fundamentals of agricultural vehicles

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Develop knowledge on commercial marine vehicles.
2. Explain the knowledge on fundamentals of reefers and gas carriers
3. Develop the knowledge on ROV, UMS ships
4. Apply the knowledge on Autonomous Underwater Vehicle
5. Apply the knowledge on Manned and Un Manned Submersible.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2											1	
2	1	2											1	
3	2	1											1	
4	3	2											3	
5	1	2											1	

UNIT I **9 Hours**

INTRODUCTION

Types – general – by function – commercial marine vehicles- passenger ship, cargo ships, oil and chemical tankers, cattle carriers, harbor crafts, off shore platform, container ships.

UNIT II **9 Hours**

REEFERS AND GAS CARRIERS

Introduction – Types, design considerations, safety – operation and controls, precaution during bunkering.

UNIT III **9 Hours**

REMOTELY OPERABLE VEHICLE (ROV), UMS SHIPS

Remotely Operable Vehicles (ROV) – The ROV business – Design theory and standards – control and simulation – design and stability – components of ROV – applications, UMS operation, and controls.

UNIT IV **9 Hours**

SUBMERSIBLES AND AUTONOMOUS UNDERWATER VEHICLE (AUV)

Submersibles types – applications, AUV – Design and construction considerations – components – sensors – Navigation -control strategies – applications

UNIT V **9 Hours**

MANNED AND UN MANNED SUBMERSIBLE

Introduction – Design and operational consideration – pressure hull exo-structure – ballasting and trim – maneuvering and control – Life support and habitability – emergency devices and equipment's – certification and classification, towed vehicles – gliders – crawler – Design and construction.

Total: 45 Hours

Reference(s)

1. Ferial L hawry, The ocean engineering handbook, CRC press,2000
2. Richard A Geyer, "Submersibles and their use in oceanography and ocean engineering", Elsevier, 1997
3. Robert D. Christ,Robert L. Wernli, Sr. "The ROV Manual A User Guide for Remotely Operated Vehicles", Elsevier, second edition, 2014
4. Jonathan M. Ross, human factors for naval marine vehicle design and operation, CRC press, 2013
5. Sabiha A. Wadoo, Pushkin Kachroo, Autonomous underwater vehicles, modelling, control design and Simulation, CRC press, 2011.

21AU031 OFF-ROAD VEHICLES 3 0 0 3

Course Objectives

- To acquire knowledge on construction and working of heavy-duty vehicles intended for off-road use
- To understand the basic differences between all the common transmissions and drive trains used on off- road vehicles
- To explain the basic traction properties of off- road vehicles
- To understand the various farm equipment vehicle and their systems and features.
- To impart the knowledge on military and combat vehicles.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Select the suitable earth moving machines based on their power and load carrying capacities.
2. Demonstrate the application of construction Equipments.
3. Select the suitable tractor for given application.
4. Analyze the transmissions and drive trains used on military and combat vehicles.
5. Select the suitable hydraulic systems for Dumper and backhoe.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1										2	
2	2	2	1										2	
3	3	2	1										2	
4	1	3	2										2	
5	2	3	1										2	

UNIT I **9 Hours**

EARTH MOVING MACHINES

Bulldozers, cable and hydraulic dozers. Crawler track, running and steering gears, scrapers, drag and self- powered types. Dump trucks and dumpers. Loaders - single bucket, multi bucket and rotary types, Excavators, Power and capacity of earth moving machines.

UNIT II **9 Hours**

SCRAPPERS, GRADERS, SHOVELS AND DITCHERS

Scrapers, elevating graders, self-powered scrapers and graders. Power shovel, revolving and stripper shovels, ditchers and capacity of shovels. Bush cutter, stampers, tree dozer and rippers.

UNIT III **9 Hours**

TRACTOR

Tractor-classification, Tractor controls and starting of tractor engine, Transmission- Stop and shift type, On the go shift type, transfer cases, Drive axles for wheeled tractor and row-crop tractors, rear axle of crawler tractor, Frame and suspension, Running gear of crawler tractor.

UNIT IV **9 Hours**

FARM EQUIPMENTS, MILITARY AND COMBAT VEHICLES

Farm equipment"s - power tiller, rotavator, gyrovator, laser leveller, cane thumper, sickle sword, fertilizer spreader, baler, mulcher, shredder, harvestor and rice transplanter. Special features and constructional details of tankers and gun carriers.

UNIT V **9 Hours**

HYDRAULICS AND HEAVY EQUIPMENT OPERATIONS

Basics hydraulics system-principle, components, advantages and disadvantages, Bulldozer hydraulic system, Dumper truck hydraulic system, Excavator hydraulic system, Scraper hydraulic system, Backhoes hydraulic system, Hydraulic traction booster for tractors.

Total: 45 Hours

Reference(s)

1. H.P. Smith, Farm Machinery and Equipment, Belgium: Morse Press, 2011.
2. D. Sheridan, Off-road vehicles on public land, Ann Arbor: University of Michigan Library, 1979.
3. C.P. Nakra, Farm Machines and Equipment, New Delhi: Dhanpat Rai Publishing Company Pvt. Ltd, 2003.
4. J.Y. Wong, Terramechanics and Off-road Vehicles, Oxford: Elsevier Science Ltd, 1989.
5. Graham, Off-Road Vehicles, London: Heinemann Library, 2008.
6. Ia. S. Ageikin, Off the Road Wheeled and Combined Traction Devices: Theory and Calculation, Burlington: Ashgate Publishing Co. Ltd, 1988.

21AU032 DRONE TECHNOLOGIES 3 0 0 3

Course Objectives

- To impart knowledge on the hardware components and their application in the UAV systems.
- To infer about the communication and control detail of UAV.
- To introduce the basic operational futures of UAV systems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Demonstrate the importance of UAVs with respect to their applications.
2. Demonstrate the application of subsystems and configurations of UAV.
3. Select the suitable UVA for given application.
4. Perform ground test and troubleshooting with respect to UAV operation.
5. Select the suitable design standards and regulatory aspects of UAVs.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1										2	
2	2	2	1										2	
3	3	2	1										2	
4	1	3	2										2	
5	2	3	1										2	

UNIT I **9 Hours**

INTRODUCTION TO UAV

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications.

UNIT II **9 Hours**

THE DESIGN OF UAV SYSTEM

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations- Characteristics of Aircraft Types- Design Standards and Regulatory Aspects UK,USA and Europe- Design for Stealth--control surfaces-specifications.

UNIT III **9 Hours**

AVIONICS HARDWARE

Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply processor, integration, installation, configuration, and testing.

UNIT IV **9Hours**

COMMUNICATION PAYLOADS AND CONTROLS

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequencyrange –modems-memory system-simulation-ground test-analysis-trouble shooting.

UNIT V **9 Hours**

DEVELOPMENT OF UAV SYSTEMS

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

Reference(s)

1. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems",Lockheed Martin AeronauticsCompany, 2001.
2. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Roadto Autonomy", Springer, 2007.
3. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems,Inc,1998.
4. Reg Austin "unmanned aircraft systems UAV design, development and deployment",Wiley,2010.
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

21AU033 AUTOMOTIVE PRODUCT DESIGN AND DEVELOPMENT

3 0 0 3

Course Objectives

- To acquire knowledge on product design and apply them in practice
- To develop understanding of the fundamentals of new product development

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

m An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Analyze the parameters required for new product development.
2. Analyze the design requirement for new product development
3. Demonstrate product models produced using prototyping machines
4. Explain the various costs associated with the new product development
5. Implement recent advancements in product design.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2											1		
2	1	2											1		
3	2	1											1		
4	3	2											3		
5	1	2											1		

UNIT I **9 Hours**

NEW PRODUCT DEVELOPMENT

Importance of manufacturing-Basic concepts-Capital Circulation, manufacturing capability, mass production, Interchangeability, Product Life Cycle, The S-Curve of Technology Growth Cycle, Concurrent Engineering , Design for X , Engineering problem solving process, Key factors to develop successful products, Strategy for new product development.

UNIT II **9 Hours**

PRODUCT DESIGN

Requirements of design - design process- Top Down and Bottom up Approach, design review, Quality Control- Reactive vs Proactive, Six sigma, Poka-yoke, Consideration and selection of Materials, selection of process and design consideration, case studies- Guidelines for Casting, Forging and Extrusion.

9 Hours

UNIT III

PRODUCT MODELING

Product modeling - definition of concept, types of product models, types of process chains, industrial demands, Prototyping - principles, technologies, robust design, process.

9 Hours

UNIT IV

PRODUCT COSTING

Bill of materials - outline process charts , cost estimating procedure, methods of costing , material cost, Labor cost, Overheads ,Depreciation , Break even analysis - problems.

9 Hours

UNIT V

RECENT ADVANCES AND CONCEPTS IN PRODUCT DESIGN

Fundamentals of FEM, Significance to product design, Product life cycle management, Functional Analysis System Techniques, Ergonomics in Product Design, Management information system ,need, application, functions..

Total: 45 Hours

Reference(s)

1. K.T. Ulrich, S. D. Eppinger, Product Design and Development, McGraw-Hill, 2011.
2. G.E. Dieter, Engineering Design- A Materials and process approach, Tata McGraw-Hill,2008
3. D. E. Carter, Concurrent Engineering, Addison Wesley, 2004.
4. Anil Mital, Anoop Desai, Aashi mital, Product Development: A StructuredApproach to Design and Manufacture, Butterworth-Heinemann ,2008.
5. https://onlinecourses.nptel.ac.in/noc19_me21/previe

21AU034 ERGONOMICS IN AUTOMOTIVE DESIGN 3 0 0 3

Course Objectives

- To comprehend the concepts of automotive styling in the broader context of vehicle styling.
- To appraise the possessions of interior and exterior designing of an automobile.
- To procure knowledge on the clay modelling and software modelling of a vehicle.

Programme Outcomes (POs)

a. Apply the fundamental knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, automotive engines, automotive mechanics, automotive electrical system, thermodynamics, material and manufacturing sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations with the knowledge of vehicle body engineering, design of automotive chassis components, automotive emission and control and design of automotive engine components.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m .Design, analyze and optimize the solutions for automotive components and systems.

Course Outcomes (COs)

1. Understand the concepts of automotive interior and exterior design
2. Identify the different materials and manufacturing processes used in designing bodies
3. Apply the concepts adopted in designing automotive bodies
4. Analyze the safety and impact analysis methods in automobiles
5. Summarise the methodology, prototyping, digital design and visualization of automotive design management

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3										3		
2	3	2	3										3		
3	3		3		2								2		
4	3		3										3		
5	3		3		3								2		

UNIT I **9 Hours**

INTRODUCTION:

Definition, human technological system, multidisciplinary engineering approach, human – machine system, manual, mechanical, automated system, human system reliability, conceptual design, advanced development, detailed design and development, human system modeling

UNIT II **9 Hours**

BIOMECHANICS

Biostatic mechanics, statics of rigid bodies, upper extremity of hand, lower extremity and foot, bending, lifting and carrying, biodynamic mechanics, human body kinematics, kinetics, impact and collision. Input and processing, text, graphics, symbols, codes, visual display of dynamic information, auditory, tactual, displays, speech communications.

UNIT III **9 Hours**

BIOTHERMODYNAMICS AND BIOENERGITICS

Body Design: Automotive styling and sketching – Streamlining - Automotive concept design using clay modelling and sculpting technique - Freeform and surface modelling - Vehicle aerodynamics and thermal managemen Bio-thermal fundamentals, human operator heat transfer, human system bioenergetics, thermoregulatory physiology, human operator thermo regularity, passive operator, active operator, heat stress.

UNIT IV **9 Hours**

VEHICLE ERGONOMICS

Introduction, seating dimensions, interior ergonomics, ergonomics system design, seat comfort, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout.

UNIT V **9 Hours**

ENVIRONMENTAL CONDITIONS

Illumination, heat ventilation and air conditioning, noise, motion, speed and acceleration, sound, vibration. Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO/DIS6385, OSHA's approach, virtual environments.

Total: 45 Hours

Reference(s)

1. Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London, 2003.
2. Chandler Allen Phillips, "Human Factors Engineering", John Wiley & Sons, New York, 2000.
3. Martin Helandar, "A Guide to Ergonomics of Manufacturing", Taylor and Francis, 1996.
4. William D. Callister, Jr., — Materials Science and Engineering- An Introduction, 9th Mark S S, "Human Factors in Engineering and Design", McGraw Hill, New York, 1993.
5. John Fenton, "Hand Book of Automotive Power Train and Chassis Design", SAE, 1998.

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21AU035 ADDITIVE MANUFACTURING 3 0 0 3

Course Objectives

- To provide knowledge on generic steps of Additive Manufacturing (AM) technique.
- To learn the concept and applications of liquid and solid based AM processes
- To impart knowledge on powder-based AM processes.
- To introduce the concept of open-source 3D printers and rapid tooling
- To expose the emerging trends and applications of Additive Manufacturing technology

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
n. An ability to use computer knowledge, IT for designing and improving the performance of the automobiles

Course Outcomes (COs)

1. Explain the generic steps and classification of Additive Manufacturing processes.
2. Select the suitable material and AM process based on applications.
3. Identify the suitable AM process to fabricate metallic components.
4. Design their own open-source 3D printer based on application.
5. Implement the reverse engineering techniques for developing prototype

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2		2									2
2	2	2	1		2									2
3	2	2	1		2									2
4	2	2	1		2									2
5	2	2	2		2									2

UNIT I **7 Hours**

INTRODUCTION

Needs - Impact of AM and Rapid Tooling on Product Development - Distinction between AM and CNC Machining- The Generalized AM Process chain - CAD Model - Input file formats - Generation and

Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - RP Benefits - Classification of RP systems

UNIT II **7 Hours**

LIQUID POLYMER AND SOLID BASED SYSTEMS

Stereolithography Apparatus (SLA), Digital Light Projection (DLP), Continuous Liquid Interface Production (CLIP), Photo polymerization process, Fused Deposition Modeling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Materials and Applications.

UNIT III **10 Hours**

POWDER BASED SYSTEMS

Selective Laser Sintering (SLS), Color Jet Printing, Direct Metal Deposition (DMD), Ballistic Particle Manufacturing (BPM), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS)- Working Principle, Construction, Process Variables, Materials and Applications

UNIT IV **11 Hours**

OPEN-SOURCE PRINTER AND RAPID TOOLING

Concept of open-source 3D printer - Structural details, Control mechanism - Materials and Applications. Introduction to rapid tooling (RT) - Direct and Indirect tooling - Silicone rubber moulding, Epoxy tooling, Spray Metal Coating, 3D printing direct, Electro Optical Sintering (EOS) - Working Principle, Materials and Applications

UNIT V **10 Hours**

REVERSE ENGINEERING AND APPLICATIONS OF ADDITIVE MANUFACTURING

Reverse Engineering - Application of CMM, Laser scanner, CT and MRI scan in acquiring point data - Software for STL file processing. Application of Rapid prototyping in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries. Leading manufacturer of RP systems

Total: 45 Hours

Reference(s)

1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
2. D. T.Pham and S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
3. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
4. L.W. Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A toolbox for prototype development, CRC Press, 2013.
5. Yang, L., Hsu, K., Baughman, B., Godfrey, D., Medina, F., Menon, M., Wiener, S., Additive Manufacturing of Metals: The Technology, Materials, Design and Production, Springer, 2017 https://doi.org/10.1007/978-3-319-55128-9
6. www.all3dp.com, www.3dprintingindustry.com, www.reprap.org, www.thingiverse.com

21AU036 NEW PRODUCT DEVELOPMENT PROCESS 3 0 0 3

Course Objectives

- To introduce the importance of product design
- To understand the needs of a customer towards a product
- To initiate the idea of creativeness on product
- To understand the decision- making concepts.
- To design a product based on cost frame and need of the customer.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Introduce the importance of product design
2. Understand the needs of a customer towards a product
3. Initiate the idea of creativeness on product
4. Understand the decision- making concepts.
5. Design a product based on cost frame and need of the customer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2											1		
2	1	2											1		
3	2	1											1		
4	3	2											3		
5	1	2											1		

UNIT I **10 Hours**

INTRODUCTION

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development- planning for products –establishing markets- market segments- relevance of market research.

UNIT II **10 Hours**

CUSTOMER NEEDS

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies.

UNIT III **8 Hours**

CREATIVE THINKING

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition – functional representation –morphological methods- TRIZ- axiomatic design.

UNIT IV **9 Hours**

DECISION MAKING AND PRODUCT ARCHITECTURE

Decision making –decision theory –utility theory –decision trees –concept evaluation methods – Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture.

UNIT V **8 Hours**

DESIGN AND COST ANALYSIS

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.

Total: 45 Hours

Reference(s)

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw- Hill Education, ISBN- 10- 007- 14679- 9.

2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2015, Pearson Education, ISBN 9788177588217.

3. Clive L.Dym, Patrick Little, "Engineering Design: A Project- based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978- 0- 470- 22596- 7.

4. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw- Hill International Edition, 4th Edition, 2009, ISBN 978- 007- 127189- 9.

5. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

21AU037 AUTOMOTIVE PRODUCT LIFE AND MANAGEMENT

3 0 0 3

Course Objectives

- To acquire knowledge on product design and apply them in practice
- To develop understanding of the fundamentals of new product development

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
m. An ability to design, analyze and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Analyze the parameters required for new product development.
2. Analyze the design requirement for new product development
3. Demonstrate product models produced using prototyping machines
4. Explain the various costs associated with the new product development
5. Implement recent advancements in product design.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2											1		
2	1	2											1		
3	2	1											1		
4	3	2											3		
5	1	2											1		

UNIT I **10 Hours**

MOTIVATION AND INTRODUCTION

E-commerce, B to B, B to C forms of business, extended enterprise, concepts in PDM - product life cycle, business objects, work flows, versions, views, product structure, change processes, work list, information flow model in product development, engineering bill of materials and manufacturing bill of materials.

UNIT II **10 Hours**

COMPONENTS OF PLM SOLUTIONS

Object oriented approach in product development solutions, phase gate process in product design - disparate databases and connectivity, use of EAI technology (middleware) - cases for preparation of combined BOM and other reports. Component supplier management and sourcing.

UNIT III **8 Hours**

PRODUCT VISUALISATION

CAD neutral environment and visualization of products, standard software, use of visualization in several stages of lifecycle, reviews, mark up - case studies. Role of PLM in industries, Automotive sectors, ten step approach to PLM, benefits of PLM.

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UNIT IV **9 Hours**

DETAILS OF MODULE

Details of modules in a PDM/PLM software, basics on customization and implementation of automotive PDM/PLM software.

UNIT V **8 Hours**

DESIGN AND COST ANALYSIS

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing.

Total: 45 Hours

Reference(s)

1. Stark John, “Product Lifecycle Management (Volume 1)”, Springer International Publishing, 2019.
2. Stark John, “Product Lifecycle Management (Volume 2)”, Springer International Publishing, 2016.
3. Wang Lihui and Andrew Y C N, “Collaborative Design and Planning for Digital Manufacturing”, Springer-Verlag London Limited, 2009.
4.Stark John, “Product Lifecycle Management (Volume 4): The Case Studies (Decision Engineering)”, Springer Publisher,2019

21AU038 AUTOMOTIVE STYLING 3 0 0 3

Course Objectives

- To comprehend the concepts of automotive styling in the broader context of vehicle styling.
- To appraise the possessions of interior and exterior designing of an automobile.
- To procure knowledge on the clay modelling and software modelling of a vehicle.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, basic engineering as it applies to automobile engineering to solve complex engineering problems

b. Identify, formulate and analyze problems related to automotive vehicles and to reach substantiated conclusions using mathematical and scientific knowledge imparted to them

c. Design and develop automobile systems , sub systems and processes that meet the desired specifications and requirements with appreciation for the public health and safety, social, environmental, ethical, economic and commercial considerations

e. Use appropriate techniques , modern engineering/IT/ product development tools and mathematical /computer-based models with an understanding of the limitations

m. An ability to identify, analyze and solve engineering problems relating to Automobile systems together with allied engineering streams.

Course Outcomes (COs)

1. Demonstrate the concepts of automotive interior and exterior design.
2. Identify the different materials and manufacturing processes used in designing bodies
3. Analyze the concepts adopted in designing automotive bodies
4. Analyze the safety and impact analysis methods in automobiles
5. Summarise the methodology, prototyping, digital design and visualization of automotive design management

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2	3	1	1	2	1	1	1	1	1	1	1	
2	2	2	2	1	2	2	2	2	2	1	1	1		1	
3	1	1	2	1	2	1	2	1	1	2	2	2	1	2	
4	2	1	1	2		1		1	1	2	1				
5	1	2	1	2		2		2	2	2	1		2	1	

UNIT I **9 Hours**

AUTOMOTIVE INTERIOR AND EXTERIOR DESIGN

Introduction - Creative and innovation - Modern automobile systems - Interior and exterior design – Colour selection - Automobile aesthetics - Vehicle body types - Body styles, front grill shapes, headlight shapes, side

vent, rear side shapes, overall profiles, visual features, vehicle color codes, Introduction to computer- aided concept design system.

UNIT II **9 Hours**

LIGHT WEIGHT VEHICLE DESIGN

Introduction to light weight vehicle design - Composite material - The manufacturing challenge for automotive designers - Advances in manufacturing processes, structure, properties and manufacturing technology of automotive materials. Design to manufacture as a single process.

UNIT III **9 Hours**

AUTOMOTIVE CONCEPT DESIGN

Body Design: Automotive styling and sketching - Streamlining - Automotive concept design using clay modelling and sculpting technique - Freeform and surface modelling - Vehicle aerodynamics and thermal management-Clay Modeling

UNIT IV **9 Hours**

STRUCTURES, SAFETY AND IMPACT

Ergonomics in automotive design, driver comfort - Seating, visibility - Man- machine system - Passenger comfort - ingress and egress - Spaciousness - Ventilation - Temperature control, dust and fume prevention and vibration. Crashworthiness and its influence on vehicle design - Accident and injury analysis - Vehicle impacts: General dynamics.

UNIT V **9 Hours**

AUTOMOTIVE DESIGN MANAGEMENT

Design methodology and research - Automotive digital design - Digital visualization - Scale models – Digital prototyping and design management.

Total: 45 Hours

Reference(s)

1. Julian Happian Smith, An Introduction to Modern Vehicle Design, Butterworth Heinemann, 2004.
2. Vivek D. Bhise, Ergonomics in the Automotive Design Process, CRC Press, 2016.
3. William D. Callister, Jr., Materials Science and Engineering - An Introduction, 9th Edition, John Wiley& Sons, 2013.
4. John Fenton, Vehicle Body Layout and Analysis, Mechanical Engg. Publication Ltd., London, 1982

21AU039 AUTOMATION IN MANUFACTURING 3 0 0 3

Course Objectives

- Describe the basic concepts of automation in manufacturing systems.
- Acquire the fundamental concepts of automated flow lines and their analysis.
- Classify automated material handling, automated storage and retrieval systems.
- Illustrate adaptive control systems and automated inspection methods.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Illustrate the basic concepts of automation in machine tools.
2. Analyze various automated flow lines, Explain assembly systems and line balancing methods.
3. Describe the importance of automated material handling and storage systems.
4. Interpret the importance of adaptive control systems, automated inspection systems.
5. Explain the system and different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1										2	
2	2	2			2								2	
3		2	3		2									
4	2	3			2								2	
5	2	3	1		2									

UNIT I **9 Hours**

INTRODUCTION AND AUTOMATED FLOW LINES

Single-Station Manufacturing Cells, types and strategies of automation, Automation in machine tools, automation principles, Mechanical feeding and tool changing, machine tool control, elements in product realization.

UNIT II **9 Hours**

ANALYSIS OFAUTOMATED FLOW LINES AND ASSEMBLY SYSTEMS AND LINE BALANCING

General terminology, analysis of transfer lines with and without buffer storage, partial automation, implementation of automated flow lines. Assembly process, Manual Assembly Lines, Line balancing methods, ways for improving line balance, flexible assembly lines.

UNIT III **9 Hours**

AUTOMATED MATERIAL HANDLING AND AUTOMATED STORAGE SYSTEMS

Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems. Automated storage and retrieval systems work in process storage, inter facing and ling and storage with manufacturing

UNIT IV **9 Hours**

ADAPTIVE CONTROL SYSTEMS

Introduction – Adaptive control with optimization, Adaptive control with constraints, Application of Adaptive control in Machining operations. Uses of various parameters such as cutting force, Temperature, vibration and acoustic emission Adaptive control.

UNIT V **9 Hours**

AUTOMATED INSPECTION

Fundamentals, types of inspection methods and equipment, CMM, Types, methods of CMM control, Machine vision- Introduction, image acquisition, and image processing applications of machine vision.

Total: 45 Hours

Reference(s)

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover./PE/PHI.
2. Computer Control of Manufacturing Systems: Yoram Coren.
3. CAD/CAM/CIM, (2nd Edition),by Radhakrishnan and Subramanian, New Age Publications.
4. Automation by W. Buekinsham.

21AU040 MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE 3 0 0 3

Course Objectives

- Impart knowledge on basic concepts of aggregate planning, manufacturing planning and
- enterprise resource planning.
- Pivot foundation in material planning concepts.
- Articulate knowledge on inventory management models.
- Educate the purchasing techniques and concepts.
- Exposure on warehouse management activities.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Understand drive mechanisms and hoisting gear for different handling applications.
2. Apply different conveyor systems for material handling applications.
3. Analyse bucket, cage and fork lift elevators for to and fro transportation of .materials in vertical direction.
4. Analyse of integrated mechanical system for machine tools, power transmission and engine parts.
5. Understand warehouse management activities.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2		2								2	
2	2	2											2	
3	2		3		2									
4	2	3											2	
5	2	3			2									

UNIT I **9 Hours**

DRIVES OF HOISTING GEAR

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT II **9 Hours**

CONVEYORS

Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT III **9 Hours**

ELEVATORS

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks

UNIT IV **9 Hours**

INTEGRATED DESIGN

Integrated Design of systems - Valve Gear Mechanisms, Portable Air Compressor, Hay-Bale lifter, Cam Testing Machine, Power Screws, Gear Box Design more than six speed.

UNIT V **9 Hours**

WAREHOUSE MANAGEMENT

Warehousing functions – types - Stores management-stores systems and procedures-incoming materials control-stores accounting and stock Verification-Obsolete, surplus and scrap-value analysis-material handling-transportation and traffic management -operational efficiency productivity-cost effectiveness-performance measurement.

Total: 45 Hours

Reference(s)

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958
3. Norton. L Robert. “Machine Design – An Integrated Approach” Pearson Education, 2nd Edition, 2005.
4. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
5. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
6. \J.R.Tony Arnold, Stephen N. Chapman, Lloyd M. Clive, Materials Management, Pearson, 2012.

21AU041 ROBOTICS 3 0 0 3

Course Objectives

- Describe the basic concepts of robotics in manufacturing systems.
- Acquire the fundamental concepts of robotics.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Explain the concepts of industrial robots, classification, specifications and coordinate systems. Also summarize the need and application of robots in different sectors.
2. Illustrate the different types of robot drive systems as well as robot end effectors.
3. Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
4. Develop robotic programs for different tasks and familiarize with the kinematics motions of robot.
5. Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2										2	
2	2				2								2	
3		2	3		2									
4	2	3	2		2								2	
5	2	3	1											

UNIT I **9 Hours**

FUNDAMENTALS OF ROBOT

Robot - Definition - Robot Anatomy – Co-ordinate Systems, Work Envelope Types and Classification-Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT II **9 Hours**

ROBOT DRIVE SYSTEMS AND END EFFECTORS

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III **9 Hours**

SENSORS AND MACHINE VISION

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications, Inspection, Identification, Visual Serving and Navigation.

UNIT IV **9 Hours**

ROBOT KINEMATICS AND ROBOT PROGRAMMING

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Expert system, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT V **9 Hours**

IMPLEMENTATION AND ROBOT ECONOMICS

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

Total: 45 Hours

Reference(s)

1. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2012.
2. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
3. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008. 2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
5. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995

21AU042 LOGISTICS IN MANUFACTURING, SUPPLY CHAIN AND DISTRIBUTION 3 0 0 3

Course Objectives

- Applying the fundamental concepts and principles of logistics and supply chain in manufacturing systems.
- Applying the concept and principles of information, demand forecasting, inventory in manufacturing systems.
- Applying the concept and principles in solving problems in transportation, warehousing & distribution in manufacturing systems.
- Applying the concept and principles of protective packaging, order processing, materials handling, purchasing & sourcing in manufacturing systems.
- Applying the concept and principles of logistics and supply chain administration in manufacturing systems.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineeringproblems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

1. Apply the fundamental concepts and principles of logistics and supply chain in manufacturing systems.
2. Apply the concept and principles of information, demand forecasting, inventory in manufacturing systems.
3. Apply the concept and principles in solving problems in transportation, warehousing & distribution in manufacturing systems.
4. Apply the concept and principles of protective packaging,order processing, materials handling, purchasing & sourcing in manufacturing systems.
5. Apply the concept and principles of logistics and supply chain administration in manufacturing systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2										2	
2	2	2			2								2	
3			3											
4	2	3			2								2	
5	2	3	2		2									

UNIT I **9 Hours**

INTRODUCTION TO L&SCM

Logistics: Nature & Concepts – Evolution – Importance – Advantage – Objectives – Components – Functions – Supply Chain Management: Nature & Concepts – Value chain – Functions & Contribution – Effectiveness – Framework – Outsourcing – 3 PLs – 4 PLs – Bull whip effect – SC Relationships – Conflict resolution – Harmonious relationship – Customer Service: Nature & Concepts – Importance – Components – Cost – Gap analysis – Strategic management – Case Study.

UNIT II **9 Hours**

INFORMATION,DEMAND FORECASTING,INVENTORY MANAGEMENT

Information: Position of Information in L&SCM – Logistical Informational Systems – Operational Logistical Informational Systems – Integrated Information Technology Solution for L&SCM – Emerging L&SCM – Demand Forecasting: Nature & Components – Impact of forecast on L&SCM – Effective forecasting – Techniques – Selection – Principles – Inventory: Concepts – Types – Functions – Elements – Inventory management – ABC analysis – ABC-VED matrix – Materials Requirement Planning – Distribution Requirement Planning – Just in Time System – Prerequisites – Case study.

UNIT III **9 Hours**

TRANSPORTATION, WAREHOUSING & DISTRIBUTION

Transportation: Introduction – Position of transportation in L&SCM – Elements of transportation cost – Modes – Multimodal transport – Containerization – Selection of transportation modes – Transportation decision – Transportation network: routing & scheduling – Warehousing & Distribution Centers: Introduction – Concepts – Types – Functions – Strategy – Design – Operational Mechanism – Case study

UNIT IV **9 Hours**

PROTECTIVE PACKAGING, ORDER PROCESSING, MATERIALS HANDLING, PURCHASING & SOURCING MANAGEMENT

Protective Packaging: Introduction – Concepts – Functions – Forms – Problems – Policy – Order Processing: Introduction – Concepts – Functions – Elements – Significance – Materials Handling: Introduction – Concept – Objective- Principles – Equipments – Considerations – Purchasing & Sourcing Management: Introduction – Nature – Scope – Importance – Trends – Contemporary sourcing & supplier management – Case study.

UNIT V **9 Hours**

L&SCM ADMINISTRATION

Organization: Introduction – Evolutionary trends of L&SCM – Principles – Factors. Performance Measurement: Introduction – Dimensions – Basic tools – Impediments to improve performance – Case Study.

Total: 45 Hours

Reference(s)

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover./PE/PHI.
2. Computer Control of Manufacturing Systems: Yoram Coren.
3. CAD/CAM/CIM, (2nd Edition),by Radhakrishnan and Subramanian, New Age Publications. Automation by W. Buekinsham.

21AU043 INDUSTRIAL ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production system and layout design.
- To learn about production planning and its control methods.
- To provide the knowledge of work study, process charts and ergonomic condition.
- To impart the knowledge on inventory control and material handling equipment.
- To learn about system analysis and different types of maintenance.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineeringspecialization to the solution of complex engineeringproblems.

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

m. An ability to design, analyze and find the solutions for automotive related problems

Course Outcomes (COs)

6. Select proper plant layout for the required production system.
1. Plan the resources required for the production and to perform the controlmethods.
2. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
3. Analyze the inventory required based on production needs and material handling.
4. Explain the system and different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1		1								2	
2	2	2	1		2								2	
3	1	2	3		2								2	
4	2	3	1		2								2	
5	2	3	1		2								2	

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and Development, Applications, Roles of Industrial engineer. Production management, Industrial engineering versus Production management, Operations management. Production system Analysis, Input-output model, Productivity, Factors affecting productivity. Plant layout, Criteria for a good layout, Types of layout - Process layout, Product layout, Combination layout, and Fixed position layout. Material flow pattern, Workstation design.

UNIT II **9 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning- Definition, Procedure, Process selection, Machine capacity, Process sheet, Process analysis. Group technology - Definition, Classification and coding system, Formation of component family. Production planning - Introduction, Functions, Loading, Scheduling. Production control - Dispatching, Routing. Progress control - Bar, Curve, Gantt chart, Route and Schedule chart.

UNIT III **9 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, Objectives of method study and work measurement, Method study procedure. Process chart - symbols, outline process chart, flow process chart. The flow diagram, String diagram, Multiple activity chart, Principles of motion economy, Therbligs, SIMO chart, Stopwatch procedure. Ergonomics- applications of ergonomic principles in the shop floor- work benches- seating arrangement.

UNIT IV **9 Hours**

INVENTORY MANAGEMENT AND MATERIAL HANDLING

Inventory - Definition, Objectives, Classification, Functions, Economic order quantity, Economic batch quantity, Inventory models, ABC analysis. Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, Just in Time manufacturing system, KANBAN technique, Material handling - Definition, Functions, Principles, Equipment selection, and Equipment types.

UNIT V **9 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept, System analysis, System engineering, Techniques, Applications. Value analysis/ Engineering - Definition, Types of values, Aim, Technique, Procedure, Advantages, Applications, Value engineering versus Value control. Plant maintenance department - Objectives, Importance, Duties, Functions, and Responsibilities. Types of maintenance - Breakdown, Scheduled, Preventive and Predictive. Plant maintenance schedule - Introduction, Procedure.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010.
2. Panneerselvam R., Production and operations management, Heritage Publishers, 2006.
3. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., NewDelhi, 2009.
5. Jan Dul, Bernard Weerdmeester, Ergonomics for Beginners: A Quick Reference Guide, CRCPress, Taylor and Francis group,2008.
6. Lee J. Krajewski, Larry P.Ritaman, Operations Management, Addison Wesley, 2007

21AU044 LEAN MANUFACTURING 3 0 0 3

Course Objectives

- To impart the knowledge on the lean principles and the need to follow these principles in industries.
- To learn about the overview of the various tools and techniques involved in lean manufacturing used in industries.
- To provide the necessary skills needed to analyse a given situation to draw the current state map and to identify potential improvement areas and then draw the future state map.
- To impart the knowledge on understanding of the various tools used in a six sigma project for quality improvement.
- To provide an overview of the DMAIC methodology in a six sigma project.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. Understand the impact of the professional engineering solutions in societal and environmentalcontexts, and demonstrate the knowledge of, and the need for sustainable development.

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

m. An ability to design, analyse and find the solutions for automotive related problems.

Course Outcomes (COs)

1. Understand the importance and evolution of lean principles.
2. Apply the various tools, techniques and methodology of lean manufacturing to improve the efficiency of an organization.
3. Apply the technique of value stream mapping to improve an organization by drawing current and future state maps.
4. Analyze the various tools and techniques needed for a six sigma project.
5. Apply six sigma methodology to improve quality in a manufacturing organisation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1						2	2							
2		2	3	2				2			2	3	3	
3		2	3	2	2			1	2	2	3		2	
4		2	2	3	3			2				3	2	
5		2	3	2	3			2	2	2	3		3	

UNIT I **9 Hours**

EVOLUTION AND OVERVIEW OF LEAN MANUFACTURING

Evolution of Mass production, Traditional versus Mass production, Evolution of Toyota (Lean) Production System, Business Dynamics of Lean production, Principles of Lean production – Value, Value stream, Flow, Pull, Perfection.

UNIT II **9 Hours**

LEAN MANUFACTURING – TOOLS AND TECHNIQUES

3Ms – Muda, Mura, Muri, 7 Wastes in Manufacturing, Lean Tools to eliminate Muda - 5S, Standardised work, TPM, SMED, Jidoka – Poka Yoke, JIT, Heijunka, Kanban, One piece production, Case studies.

UNIT III **9 Hours**

VALUE STREAM MAPPING

Need for Value Stream mapping; Steps involved in Value stream mapping – Choose value stream – PQ and PR analysis, Current State map, Lean Metrics, Future State Map, Kaizen plans; Lean implementation - Cultural change, Hoshin planning; Lean in the Supply chain.

UNIT IV **9 Hours**

SIX SIGMA – TOOLS AND TECHNIQUES

Integrated quality control - Off-line vs On-line inspection, Cost of Quality – Conformance and Non Conformance cost, 7 Basic Quality Control Tools, Seven Management tools, FMEA.

UNIT V **9 Hours**

SIX SIGMA METHODOLOGY

Statistical theory, Need for Six Sigma, Six Sigma Team, DMAIC Methodology – Various quality tools used in the Define, Measure, Analyse, Improve and Control phases; Lean Six Sigma, Design for lean six sigma, Case studies.

Total: 45 Hours

Reference(s)

1. Issa Bass and Barbara Lawton, Lean Six Sigma using Sigma XL and Minitab, Tata McGraw Hill 2017.
2. Pascal Dennis, Lean production Simplified: A plain language guide to the world's most powerful Production system, Productivity Press 2017.
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