M.E. Industrial Automation and Robotics

2018 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NAAC with 'A' Grade)
SATHYAMANGALAM – 638 401 Erode District Tamil Nadu
Phone : 04295 226000 Fax : 04295 226666
Web:www.bitsathy.ac.in E-mail : stayahead@bitsathy.ac.in

CONTENTS

REGULATIONS 2018
(CHOICE BASED CREDIT SYSTEM)

(Common to all M.E./M.Tech. Degree Programmes)

NOTE: *The regulations given hereunder are subject to amendments as may be decided by the Academic Council of the Institute from time to time. Any or all such amendments will be effective from such date and to such batches of students including those already in the middle of the programme as may be decided by the Academic Council.*

1. ELIGIBILITY FOR ADMISSION

(i) Candidates seeking admission to the First Semester of M. E. / M. Tech. degree programmes will be required to satisfy the eligibility criteria for admission thereto prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai.

(ii) Part - time candidates should satisfy conditions regarding experience, sponsorship, place of work and other requirements that may be prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai from time to time, in addition to satisfying requirements as in Clause 1 (i).

2. DURATION OF THE PROGRAMME

(i) **Minimum Duration:** Master of Engineering (M.E.) / Master of Technology (M.Tech.) extends over a period of two years. The two academic years (Part-time three academic years) will be divided into four semesters (Part-time six Semesters) with two semesters per year.

(ii) **Maximum Duration**: A candidate shall complete all the passing requirements of M. E. / M. Tech. programmes within a maximum period of 4 years / 8 semesters in case of full-time programme and 6 years / 12 semesters in case of part-time programme, these periods being reckoned from the commencement of the First semester to which the candidate was first admitted, regardless to the break-of-study availed.

3. BRANCHES OF STUDY

Following M.E. / M.Tech. Programmes are offered by the Institute

M.E. Programmes

1. Applied Electronics
2. CAD/CAM
3. Communication Systems
4. Computer Science and Engineering
5. Embedded Systems
6. Engineering Design
7. Industrial Automation and Robotics
8. Industrial Safety Engineering
9. Instrumentation Engineering
10. Power Electronics and Drives
11. Software Engineering
12. Structural Engineering

13. VLSI Design

M. Tech. Programme

14. Biotechnology

4. STRUCTURE OF PROGRAMMES

(i) **Curriculum:** Every Post Graduate Programme will have a curriculum with syllabi consisting of theory and practical courses that include **Professional Core** (core courses relevant to the chosen specialization), **Professional Electives** (elective courses) and **Employability Enhancement Courses** (Practical courses, Project Work, Internship, Miniproject and Industrial / Practical Training).

(ii) **Project Work:** Every student, individually, shall undertake Dissertation Phase - I during the third semester (fifth semester for part-time programme) and Dissertation Phase - II during the fourth semester (Sixth semester for part-time programme) under the supervision of a qualified faculty (faculty members with Ph.D. or P.G. with a minimum of 3 years of teaching experience). The Dissertation Phase - II shall be a continuation work of the Dissertation Phase - I. The project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide and the Head of the Department. In case of project work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization.

(iii) **Elective Courses: Seven Elective** courses are offered to the students admitted in various disciplines as prescribed in the curriculum to widen their knowledge in their specialization area.

(iv) **Online Courses:** A Student may be permitted to credit online courses with the approval of a Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. Such students may be exempted from attending the classes, if such course(s) are offered in the semester. Summary of such on-line courses, taken by the students, along with the offering agency shall be presented to the Academic Council for information and further suggestions. However, the student needs to obtain certification from the agency offering the course to become eligible for writing or seeking exemption from the End Semester Examination. In case of credits earned through online mode from the Institute / University, the credits may also be transferred directly after due approval from the Departmental Consultative Committee and the Office of the Controller of Examinations.

(v) **Industrial Training:** Every full-time student shall take-up training in the industry / research laboratories, under the supervision of a faculty guide during summer / winter vacation till pre-final semester of the programme subject to the evaluation prescribed in the Clause 15. Credits of such courses will be indicated for the course in the Grade Sheet if the student passes, but it will not be considered for computing CGPA.

(vi) **Mini Project**: A Mini Project shall be undertaken by the students individually in consultation with the respective faculty and Head of the Department, as specified in the curriculum. A student is expected to make a presentation about the mini-project during the final evaluation as given in the Clause 15.

(vii) **Value Added / Certificate Courses:** Students can opt for any one of the Value added Courses in II and III semester, approved by the Academic Council. A separate Certificate will be issued on successful completion of the Course by the Controller of Examinations.

(viii) **Credit Assignment:** Each course is normally assigned a certain number of credits with 1 credit per lecture hour per week, 1 credit for 2 hours of practical per week, 1 credit for 1 hours of tutorial per week, The exact numbers of credits assigned to the different courses of various programmes are decided by the respective Boards of Studies.

(ix) **Minimum Credits:** For the award of the degree, the student shall earn a minimum number of total credits as prescribed by the respective Board of Studies as given below:

S.No.	**M.E./M. Tech. Programmes**	**Total Credits**
1.	M.E. Applied Electronics	69
2.	M.E. CAD / CAM	70
3.	M.E. Communication Systems	70
4.	M.E. Computer Science and Engineering	70
5.	M.E. Embedded Systems	70
6.	M.E. Engineering Design	70
7.	M.E. Power Electronics and Drives	69
8.	M.E. Software Engineering	70
9.	M.E. Structural Engineering	69
10.	M.E. VLSI Design	70
11.	M.E. Industrial Safety Engineering	70
12.	M.E. Industrial Automation and Robotics	69
13.	M.E. Instrumentation Engineering	69
14.	M.Tech. Biotechnology	69

5. COURSE ENROLLMENT AND REGISTRATION

5.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 7) who shall advise / counsel the student about the details of the academic programme and the choice of courses considering the student's academic background and career objectives.

5.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the semester concerned.

5.3 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the End Semester Examinations.

5.3.1 Each student on admission to the programme shall register for all the **courses prescribed in the curriculum** in the **first Semester of study**.

5.3.2 The enrolment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the Semester II.

5.3.3 If a student wishes, the student may drop or add courses (vide Clause 5.5) within **five** working days after the commencement of the semester concerned and complete the registration process duly authorized by the PG coordinator of the programme. In the case, if a student fails in a course, he / she may be permitted to register the course in the subsequent semester or when it is offered.

5.3.4 A student who has passed all the courses prescribed in the curriculum for the award of the degree shall not be permitted to re-enroll to improve the student's marks in a course or the aggregate marks / CGPA.

5.4 Minimum Credits to Register for Project work

The Project work for M.E. / M.Tech. consists of Dissertation Phase - I and Dissertation Phase - II. The Dissertation Phase - I is to be undertaken during III semester (V semester for part-time programme) and Dissertation Phase - II, which is a continuation of Phase – I is to be undertaken during IV semester (VI semester for part-time programme). Minimum 24 credits are required to be earned to enroll the Dissertation Phase - I.

If a student fails to earn the requisite minimum credits, the student cannot enroll for the Dissertation Phase - I. In such a case, the student can enroll for the project work in a subsequent semester, after earning the minimum credits specified.

5.5 Flexibility to Add or Drop courses

5.5.1 A student has to earn the total number of credits specified in the curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum of the student's programme by opting for additional courses.

5.5.2 From the II to final semesters, the student has the option of registering for additional courses or dropping existing courses. Total number of credits of such courses cannot exceed 6. In such cases, the attendance requirement as stated Clause 6 is mandatory.

5.6 Reappearance Registration

5.6.1 If a student fails in a theory course, the student shall do reappearance registration for that course in the subsequent semester or when it is offered next.

5.6.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes. However, the attendance requirement (vide Clause 6) is not compulsory for such courses.

5.6.3 The student who fails in any practical / Miniproject or any other EEC courses shall register for the same in the subsequent semester or when offered next, and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6) and earn Continuous Assessment marks.

5.6.4 The student who fails in Dissertation Phase I / II shall register for the same in the subsequent semester or when offered next, and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6), earn Continuous Assessment marks and appear for the End Semester Examinations. Reappearance Registration is not available for such courses.

5.6.5 If a student is prevented from writing the end semester examination of a course due to lack of attendance, the student has to register for that course again, when offered next, attend the classes and fulfil the attendance requirements as per Clause 6.

6. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide clause 6.1 and 6.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

Each semester shall normally consist of 75 working days or 540 periods of each 50 minutes duration, for full-time mode of study or 250 periods for part-time mode of study.

6.1 Ideally every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance (Physical presence) course wise taking into account the number of periods required for that course as specified in the curriculum.

6.2 If a student secures attendance between 70% and 79% in any course in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/ International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department. Such certificates shall be forwarded to the Controller of Examinations for verification and for the permission to attend the examinations.

6.3 A student shall normally be permitted to appear for End Semester Examination of a course if the student has satisfied the attendance requirements (vide Clause 6.1 –

6.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

6.4 A Student who does not satisfy clause 6.1 and 6.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semester or when it is offered next (vide clause 5.6.4).

6.5 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades / marks.

7. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

8. COMMITTEES

8.1 Class Committee Meeting

(i) For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened twice in a semester, comprising members of the faculty handling all the courses and two student representatives from the class.

(ii) One of the members of the faculty (not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of this Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

9. ASSESSMENT AND PASSING REQUIREMENTS

9.1 Assessment

The assessment will comprise Continuous Assessment and End Semester Examination, carrying marks as specified in the scheme (Clause 15). All assessments will be done on absolute marks basis. However, for the purpose of reporting the performance of a student, Letter Grades and Grade Points will be awarded as per Clause 9.4.

9.2 End Semester Examinations

End Semester Examinations will normally be conducted as per the time table circulated by the Office of the Controller of Examination. A student will be permitted to appear for the End Semester Examination of a semester only if he/she

completes the study of that semester satisfying the requirements given in Clause 5 and 6, and registers simultaneously for the examinations of the highest semester eligible and the courses, pertaining to that semester, that need reappearance.

9.3 Employability Enhancement Courses

Every candidate shall submit reports on Industrial training / Mini-project, Dissertation - Phase I and Dissertation - Phase II on dates announced by the Institute / Department through the faculty guide to the Head of the Department. If a candidate fails to submit the reports of any of these courses not later than the specified date, he/she is deemed to have failed in it. The reports /papers shall be orally presented by the student before a team of expert consisting of an internal examiner, usually the supervisor, and an external examiner, appointed by the Head of the Institution.

A candidate is permitted to register for the Dissertation -Phase II, only after passing the Dissertation - Phase I. A candidate who fails in Industrial training / Mini-project, Dissertation - Phase I or Dissertation - Phase II shall register for redoing the same at the beginning of a subsequent semester.

9.4 Letter Grade and Grade Point: The Letter Grade and the Grade Point are awarded based on percentage of total marks secured by a candidate in an individual course as detailed below:

Range of Percentage of Total Marks	Grade Point	Letter grade
91 to 100	**10**	O (Outstanding)
81 to 90	**9**	A + (Excellent)
71 to 80	**8**	A (Very Good)
61 to 70	**7**	B + (Good)
50 to 60	**6**	B (Above average)
0 to 49	**0**	RA (Reappearance)
Incomplete	**0**	I
Withdrawal	**0**	W
Absent	**0**	AB

'RA' - Reappearance registration is required for that particular course

'I' - Continuous evaluation is required for that particular course in the subsequent examinations.

After completion of the evaluation process, Semester Grade Point Average (SGPA) and

Cumulative Grade Point Average is calculated using the formula:

$$SGPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

where

C_i : Credit allotted to the course.

g_i : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of SGPA and all the semesters, under consideration, in the case CGPA.

9.5 A student can apply for revaluation of his / her semester examination answer paper in a theory course, within 3 working days from the declaration of results, along with prescribed application to the Controller of Examinations through the Head of Department. Revaluation is not permitted for laboratory courses, industrial training and project works.

9.6 Passing a Course

A candidate who secures Grade Point 6 or more in any course of study will be declared to have passed that course, provided, if secures a minimum of 50% of the total mark in the End Semester Examination of that course. The Continuous Assessment (CA) marks obtained by the candidate in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 5.6.3 & 5.6.4. However, from the third attempt onwards the candidate shall be declared to have passed the course if he/she secures a minimum of 6 Grade Points in the course prescribed during the End Semester Examination alone.

9.7 Besides satisfying the above Clauses, a student shall present a technical paper, based on the courses of study, in a National or an International conference before the completion of semester IV.

10. REJOINING THE PROGRAMME

A candidate who has not completed the study of any semester as per Clause 6 or who is allowed to rejoin the programme after the period of discontinuance or who on his/her own request is permitted to repeat the study of any semester (break of study), may join the semester which he /she is eligible or permitted to join, only at the time of its normal commencement for a regular batch of candidates and after obtaining the approval from the Director of Technical Education and Anna University, Chennai. In such case, earlier Continuous Assessment in the repeated courses will be disregarded. No candidate will however be allowed to enroll in more than one semester at any point of time.

11. QUALIFYING FOR THE AWARD OF THE DEGREE

A candidate will be declared to have qualified for the award of the M.E. / M.Tech. Degree provided:

(i) he/she has successfully completed the course requirements and has passed all the prescribed courses of study of the respective programme listed in Clause 3 within the duration specified in Clause 2.

(ii) No disciplinary action is pending against the candidate.

12. CLASSIFICATION OF DEGREE

12.1 First Class with Distinction:

A student who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

M.E. / M.Tech., (Full Time)

- Should have passed the examination in all the courses of all the four semesters in the student's First Appearance within three years, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

M.E. / M.Tech. (Part Time)

- Should have passed the examination in all the courses of all the six semesters in the student's First Appearance within four years, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

12.2 First Class:

A student who satisfies the following conditions shall be declared to have passed the examination in First class:

M.E. / M.Tech. (Full Time)

- Should have passed the examination in all the courses of all four semesters within three years ,which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

M.E. / M.Tech. (Part Time)

- Should have passed the examination in all the courses of all six semesters within four years, which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

12.3 Second Class: All other students who qualify for the award of Degree shall be declared to have passed in Second Class.

13. WITHDRAWAL FROM EXAMINATION

13.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) of only once during the entire duration of the degree programme.

13.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 6 and, if such request for withdrawal is made prior to the submission of marks of the Continuous Assessment of the course(s) with the recommendations from the Head of the Department.

13.3 Withdrawal shall not be construed as an opportunity for appearance in the examination for the eligibility of a candidate for First Class with Distinction or First Class.

14. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

14.1 A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

14.2 A student who would like to avail the break of study, on account of short term employment / Medical treatment / personal reasons) shall apply to the Head of the Institution through concerned Head of the Department, (application available with the Controller of Examinations), in any case, not later than the last date for registering for the semester.

14.3 The students permitted to rejoin the programme after break of study / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of rejoining. A committee constituted by the Head of the Institution shall prescribe additional / equivalent courses, if any, from the regulation in-force, so as to bridge the requirement between curriculum in-force and the old curriculum.

14.4 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in the Clause 2, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 11 and 12).

14.5 In case of any valid reasons for the extension of break-of-study, such extended break-of-study may be granted by the Head of the Institution for a period not more than one year in addition to the earlier authorized break of study. Such extended break-of-study shall be counted for the purpose of classification of degree (vide clause 12).

14.6 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrolment. Such candidates are not entitled to seek readmission under any circumstances.

15. SCHEME OF ASSESSMENT

I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (20)	
	Periodical Test II (20)	
	Term Paper Report (5) & Presentation (5)	
	End Semester Examination	**50**
	Total Marks	**100**

II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (15)	
	Periodical Test II (15)	
	Final Lab Examination (10)	
	Viva-voce (10)	
	End Semester Examination	**50**
	(QP pattern as per (I))	
	Total Marks	**100**

III	**PRACTICAL COURSES**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (10)	
	ii. Experiment and Analysis of Results (20)	
	iii. Record (5)	
	Self-Learning Experiment (15)	
	Test - Cycle I (15)	
	Test - Cycle II (15)	
	Final Viva-voce (20)	
	Total Marks	**100**

IV	**DISSERTATION PHASE - I**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Presentation I	
	Identification of topic and Justification (10)	
	Literature Survey (10)	
	Presentation II	
	Work plan & Approach (10)	
	Progress, Results and Discussion (20)	
	End Semester Examination	
	Presentation and Demonstration (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

V	**DISSERTATION PHASE - II**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Presentation I	
	Work plan & Approach (10)	
	Presentation II	
	Progress, Results and Discussion (20)	
	Journal Publication (20)	
	End Semester Examination	
	Presentation and Demonstration (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

VI	**MINI PROJECT**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Review I (25)	
	Review II (25)	
	Report Presentation & Viva voce (50)	
	Total Marks	**100**

VII	**INDUSTRIAL TRAINING / INTERNSHIP (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Presentation and Viva-voce I	**25**
	Presentation and Viva-voce II	**25**
	Review at the Industry	**20**
	Case study / Report	**30**
	Total Marks	**100**

VIII	**VALUE ADDED COURSES / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test	50
	Final Evaluation / Test	50
	Grades (Excellent / Good / Satisfactory)	

Optional Test: *A student becomes eligible to appear for the one optional test conducted after the Periodical Test II, only under the following circumstances, if absent for Test I or Test II or both, on account of (i) medical reasons (hospitalization / accident / specific illness) (ii) participation in the College / University / State / National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned faculty member who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII and VIII listed above.*

16. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

The Question Paper Pattern (Theory Examination) for PG course is given below:

Type	**Questions**	**Marks**
Part A	2 Mark Questions (10 x 2 Marks)	20
Part B	12 Mark Questions either or pattern (5 x 12 Marks)	60
Part C	Comprehensive Type- 20 Mark Question (1 x 20 Marks)	20
	Total	100

M.E. – INDUSTRIAL AUTOMATION AND ROBOTICS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The graduates will

I. Possess good technical knowledge and competency for a successful career in engineering, implementation and development of automation solutions to industry.

II. Work with interdisciplinary groups in professional, industry and research organizations in a responsible and ethical manner.

III. Lead and engage diverse teams through effective communication, inter-personal skills and have strong commitment to pursue life-long learning.

PROGRAMME OUTCOMES (POs)

After successful completion, graduates will be able to

a) Independently carry out research /investigation and development work to solve practical problems

b) Write and present a substantial technical report/document

c) Demonstrate a high level of knowledge in specialized area related to appropriate bachelor program.

d) Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability

e) Engage in independent and life-long learning in the broadest context of technological change

f) Demonstrate knowledge and understanding of engineering principles to manage projects and in multidisciplinary environments.

MAPPING OF PEOs AND POs

PEO(s)	PROGRAMME OUTCOME(s)					
	(a)	(b)	(c)	(d)	(e)	(f)
I	X	X		X	X	
II			X			X
III		X	X		X	X

M.E: INDUSTRIAL AUTOMATION AND ROBOTICS

Minimum credits to be earned: 69

First Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IR11	ADVANCED ENGINEERING MATHEMATICS	II	1,6	3	0	0	3
18IR12	ROBOTICS	I	3,6	3	0	0	3
18IR13	SENSORS APPLICATIONS IN MANUFACTURING	I	4	3	0	0	3
18IR14	DESIGN OF FLUID POWER SYSTEMS	I	4	3	0	0	3
	ELECTIVE I			3	0	0	3
	ELECTIVE II			3	0	0	3
18IR17	SENSORS & SIGNAL CONDITIONING LABORATORY	I.II	2,3	0	0	2	1
			TOTAL	**18**	**0**	**2**	**19**
Second Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IR21	DESIGN OF MECHANISMS AND MANIPULATORS	I,II	4,6	3	0	0	3
18IR22	INDUSTRIAL AUTOMATION AND CONTROL	I	3,5	3	0	0	3
18IR23	MACHINE VISION SYSTEM	I	4	3	0	0	3
18IR24	SAFETY IN INDUSTRIAL AUTOMATION	I	4	3	0	0	3
	ELECTIVE III			3	0	0	3
	ELECTIVE IV			3	0	0	3
18IR27	ROBOTICS LABORATORY	I.II	2,3	0	0	2	1
18IR28	MINI PROJECT	III	5,8	0	0	2	1
	AUDIT COURSE I			2	0	0	0
			Total	**20**	**0**	**4**	**20**
Third Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IR31	VIRTUAL INSTRUMENTATION	I	4	3	0	0	3
	ELECTIVE V			3	0	0	3
	ELECTIVE VI			3	0	0	3
	ELECTIVE VII			3	0	0	3
18IR35	DISSERTATION PHASE – I	I,II,III	4,5,6	0	0	12	6
	AUDIT COURSE II			2	0	0	0
			Total	**14**	**0**	**12**	**18**
Fourth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IR41	DISSERTATION PHASE – II	I,II,III	3,4,5,6	**0**	**0**	**24**	**12**

List of Core Electives							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IR51	COMPUTER INTEGRATED MANUFACTURING	II	6	3	0	0	3
18IR52	INDUSTRIAL DRIVES AND CONTROL	I,II	4,6	3	0	0	3
18IR53	MODERN MANUFACTURING SYSTEM	I	3	3	0	0	3
18IR54	EMBEDDED SYSTEMS	I	4	3	0	0	3
18IR55	BASICS OF ELECTRICAL ELECTRONICS ENGINEERING	I	4	3	0	0	3
18IR56	FIELD AND SERVICE ROBOTS	I	3,4	3	0	0	3
18IR57	MODERN MATERIAL HANDLING SYSTEMS	I	4	3	0	0	3
18IR58	MICRO ELECTRO MECHANICAL SYSTEM	II	6	3	0	0	3
18IR59	ARTIFICIAL INTELLIGENCE	I,II	3,6	3	0	0	3
18IR60	FINITE ELEMENT ANALYSIS	I	3	3	0	0	3
18IR61	SMART MATERIALS	I	4	3	0	0	3
18IR62	INDUSTRIAL DATA NETWORKS	I,II	3	3	0	0	3
18IR63	PROCESS CONSULTING AND PROJECT PLANNING	III	5	3	0	0	3
18IR64	ROBOT ECONOMICS	I,II	4,6	3	0	0	3
18IR65	INTELLIGENT SYSTEMS	I,II	4,6	3	0	0	3
18IR66	CONTROL SYSTEM	I,II	4,6	3	0	0	3
18IR67	RESEARCH METHODOLOGY AND IPR	I.II	1,2,6	3	0	0	3

List of Open Electives							
Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
18GE01	BUSINESS ANALYTICS	I	6	3	0	0	3
18GE02	INDUSTRIAL SAFETY	I	5,6	3	0	0	3
18GE03	OPERATIONS RESEARCH	II	4	3	0	0	3
18GE04	COST MANAGEMENT OF ENGINEERING PROJECTS	III	6	3	0	0	3
18GE05	COMPOSITE MATERIALS	I,II	4,5	3	0	0	3
18GE06	WASTE TO ENERGY	I,II	5	3	0	0	3

List of Audit course I & II					
Code No.	Course	L	T	P	C
18XE01	RESEARCH PAPER WRITING	2	0	0	0
18XE02	TRADITIONAL TECHNICAL KNOWLEDGE	2	0	0	0
18XE03	STRESS MANAGEMENT	2	0	0	0
18XE04	DISASTER MANAGEMENT	2	0	0	0
18XE05	VALUE EDUCATION	2	0	0	0
18XE06	PEDAGOGY STUDIES	2	0	0	0

18IR11 ADVANCED ENGINEERING MATHEMATICS 3 0 0 3

Course Objective

1. To acquire the knowledge of solving equations of any nature in automation industry.
2. To enable the students to develop an engineering knowledge of the central ideas of linear algebra and to understand the concept of probability and random process in engineering field.
3. To understand the concept of the Fourier Transform as an extension of Fourier techniques on periodic functions and to solve partial differential equations.

Course Outcomes (COs)

1. Infer the ideas from Numerical methods to model the mechanical systems and solve them numerically for the automation process.
2. Analyze process in automation industry using matrix methods.
3. Acquire knowledge of periodic signals using Laplace transformation techniques and to analyze various finite difference method.
4. Apply statistical principles and properties of random variables to solve probabilistic problems of a automation system.
5. Identify the relation between any two parameters of a automation system and also to implement the concept of a point, dimensions and operations with regards to vectors.

UNIT I **9 Hours**

VECTOR SPACE

Definition and examples of vector space - Linear dependence and independence - Basis and Dimension - Inner product space – Orthogonal and Ortho normal basis - Orthogonalization process - Gram - Schmidt process. Applications of inner product spaces.

UNIT II **9 Hours**

MATRIX THEORY

Cholesky decomposition-Generalized Eigenvectors-Canonical basis-QR Factorization-Least squares method-Singular value decomposition.

UNIT III **9 Hours**

FINITE DIFFERENCE METHOD FOR ELLIPTIC EQUATION

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT IV

PROBABILITY AND RANDOM VARIABLE **9 Hours**

Probability – Axioms of probability, Conditional probability, Total probability, Baye's theorem. Random variables –Moments, Moment Generating Function and their Properties. Standard distributions: Binomial, Poisson and Normal distributions.

UNIT V **9 Hours**

LAPLACE TRANSFORM

Laplace Transform – Sufficient conditions – Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Transform of periodic functions – Inverse transforms – Convolution theorem.

Total: 45 Hours

References

1. D. C. Lay, Linear Algebra and its Applications, Addison Wesley, Massachusetts, Fourth edition, 2012.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009
3. B.S.Grewal, Numerical methods in Engineering and Science, Khanna Publishers, Tenth edition, 2014
4. H. Kobayashi, B.L .Mark and W. Turin Probability and Random process and Statistical analysis, Cambridge 2012

5. Peter V.O.N, Advanced Engineering Mathematics, Cengage Learning, USA, Seventh Edition, 2017
6. Bronson, R. "Matrix Operation", Schaum's outline series, 2ndEdition, McGraw Hill, 2011.
7. Elsgolc, L. D. "Calculus of Variations", Dover Publications, New York, 2007

18IR12 ROBOTICS 3 0 0 3

Course Objectives

1. To enlighten the students about the fundamentals of robotic systems
2. To familiarize the students with the fundamentals of sensors and it application
3. To impart knowledge about various drive systems and its selection for particular applications.
4. To execute knowledge about kinematic and dynamic analysis of robot manipulators

Course Outcomes (COs)

1. Identify the components and recognize the parameters of an Industrial Robot.
2. Estimate the gripping force of various types of grippers and list major sensors used in serial industrial robot.
3. Classify types of drive and control system.
4. Analyze robot kinematics and trajectory planning.
5. Compare scaling effect and design micro actuators.

UNIT I **9 Hours**

INTRODUCTION TO ROBOTICS

Basic Concepts such as Definition, three laws, Degrees of Freedom, Elements of Robotic Systems i.e. Robot anatomy, Configuration Associated parameters i.e. work space, resolution, accuracy, repeatability, dexterity, compliance. Work cell concept- types. Robot programming-lead through methods-capabilities and limitation of lead through methods

UNIT II **9 Hours**

ROBOT END EFFECTOR AND SENSORS

Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper systems. Sensors for Robots: Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

UNIT III **7 Hours**

DRIVES AND CONTROL SYSTEMS

Types of Drives – Electrical, Hydraulic and Pneumatic-Actuators - Selection of drives. Types of transmission, Control Systems - Open loop and Closed loop system-Types of Controllers, Process Control Systems, Discrete Control System, Continuous Versus Discrete Control.

UNIT IV **11 Hours**

ROBOT KINEMATICS

Transformation matrices and their arithmetic, link and joint description, Denavit-Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:-Jacobian, singularities, static forces, Jacobian in force domain.

UNIT V **9 Hours**

MICRO ROBOTIC SYSTEM

Micro robotics system overview-Scaling effect-Top down and bottom up approach- Actuators of Micro robotics system-communication techniques-Fabrication of micro grippers-Wall climbing micro robot working principles-Bio-mimetic robot-Swarm robot micro robot in targeted drug delivery system.

Total: 45 Hours

FOR FURTHER READING

Case Studies –Soccer playing robot, Unmanned Aerial vehicles, under water robotics, Robotics in space applications

References

1. Deb .S.R, "Robotics Technology and flexible automation", Tata McGraw-Hill Education, 2nd Edition 2017
2. Mikell P Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, AshishDutta, Industrial Robotics, "Technology Programming and Applications", McGraw Hill, 2012.
3. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", Phi Learning., 2009.
4. Saeed B Niku, "Introduction to Robotics Analysis, Control and Application" Wiley student 2nd Edition, 2014

18IR13 SENSORS APPLICATIONS IN MANUFACTURING 3 0 0 3

Course Objectives

1. To indicate the fundamentals of sensors and transducers with various signal conditioning techniques.
2. To select a suitable sensor for a specific application related to manufacturing.
3. To represent the need for advanced sensor technology in distinctive applications

Course Outcomes (COs)

1. Explain various signal condition devices used for various applications
2. Appropriate sensors for different industrial applications.
3. Describe the impact of an RFID system on manufacturing, defence, distribution, retail and health sectors
4. Describe the methods to abstract (filter) information in RFID and other sensor networks
5. Integrate various sensors in developing flexible manufacturing systems.

UNIT I **9 Hours**

FUNDAMENTALS OF SENSORS AND TRANSDUCERS

Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter.

UNIT II **9 Hours**

SENSORS AND THEIR APPLICATIONS

Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors.

UNIT III **9 Hours**

ADVANCED SENSOR TECHNOLOGIES

Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electro-magnetic identifier, optical encoders, color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for opt-electronic colour sensor in manufacturing.

UNIT IV **9 Hours**

SENSORS IN FLEXIBLE MANUFACTURING SYSTEMS

Vision sensors, image transformations, robot visual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing system cell.

UNIT V **9 Hours**

SENSORS FOR SPECIAL APPLICATIONS

A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point-contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.

Total: 45 Hours

FOR FURTHER READING

Networking of sensors, control of manufacturing process, tracking- the mean time between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.

References

1. Sabrie Soloman, Sensors and Control Systems in Manufacturing, Tata Mc-Graw Hill book India Pvt, Ltd., Second edition, 2010.
2. W. Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 6th edition, 2015.
3. Jon S. Wilson, Sensor Technology Handbook, Newnes publications, second edition, 2005.
4. A.K.Sawhney and P.Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2013.

18IR14 DESIGN OF FLUID POWER SYSTEMS 3 0 0 3

Course Objectives

1. To review the fundamentals of hydraulic and pneumatic system.
2. To select the fluid power system components based on the specific requirements.
3. To apply an appropriate method to design fluid power circuits for suitable applications.

Course Outcomes (COs)

1. Describe the components of fluid power system and compute losses in hydraulic system.
2. Compute the parameters in hydraulic components and selection of valves.
3. Construct the different hydraulic circuits for machine tool applications
4. Select the pneumatic components and construct different pneumatic circuits.
5. Design the fluid power circuits for a given application using various methods.

UNIT I **9 Hours**

INTRODUCTION

Fluid power system – Applications of Pascal's law – Components of Hydraulic and Pneumatic systems – Advantages – Drawbacks – Applications - Fluid Power symbols – Toricelli's theorem – Darcy's equation – Frictional losses: Laminar flow and turbulent flow – Losses in valves and fittings - Equivalent length Technique – Analysis of hydraulic circuit.

UNIT II **9 Hours**

SELECTION OF HYDRAULIC COMPONENTS

Calculation of hydraulic pump parameters in Gear, vane and piston pumps – Cylinder mountings and Mechanical linkages – determination of cylinder force, velocity and power: Extension and retraction stroke - cylinder loadings – selection of hydraulic cylinder – selection of hydraulic motors – Selection of control valves: Relief valve, flow control valve and directional control valve.

UNIT III **9 Hours**

HYDRAULIC CIRCUITS

Control of single acting and double acting cylinders – regenerative circuit – pump unloading circuit – synchronizing circuits – sequencing circuits – circuits for machine tools: drilling machine, planning machine, milling machine, grinding machine and press – circuits using accumulators - safety circuits – Hydraulic circuit for a robot arm – Reciprocation circuits.

UNIT IV **9 Hours**

PNEUMATIC SYSTEM

Basic pneumatic system – Pneumatic circuits: speed control circuit, quick exhaust circuit, feed control circuit, time delay circuit, automatic cylinder reciprocation circuit and safety control circuit – Selection of pneumatic components: Pneumatic cylinders, air motors – sizing of control valves and compressors – selection of filter, regulator and lubricator.

UNIT V **9 Hours**

DESIGN OF FLUID POWER CIRCUITS

Circuit design for simple applications: Classic method, cascade method, step counter method, karnaugh veitch mapping method and combinational circuit design – PLC circuit design using ladder logic

Total: 45 Hours

FOR FURTHER READING

Applications of low cost automation: Conveyor feed system and Pick and place robot

References

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, New Delhi, 2015.
2. Majumdar S.R., Oil Hydraulics Systems - Principles and Maintenance, Tata McGraw-Hill, New Delhi, 2014.
3. Majumdar S.R., Pneumatic systems – Principles and maintenance, Tata McGraw Hill, New Delhi, 2014
4. Shanmugasundaram.K, Hydraulic and Pneumatic controls, Chand & Co, New Delhi, 2013.
5. Srinivasan.R, Hydraulic and Pneumatic controls, Vijay Nicole, Chennai 2012

18IR17 SENSORS & SIGNAL CONDITIOING LABORATORY 0 0 2 1

Course Objectives

1. To impart programming skill to control the various processes
2. To interface different sensors with DAQ by using suitable software

Course Outcomes (COs)

1. Create a program to measure and control temperature.
2. Create a program to measure the vibration, strain and displacement.
3. Create a program to convert analog to digital and digital to analog signal.
4. Design of controllers for balancing the ball on desired position

LIST OF EXPERIMENTS

1	Interfacing a thermocouple to monitor the temperature in a thermal chamber and controlling a fan and heating source to maintain the temperature of the chamber within a specified tolerance limits.	**2 Hours**
2	Interfacing a RTD to monitor the temperature of cooking oven in food processing industry and controlling the temperature within the limits.	**2 Hours**
3	Measurement of damping ratio of a machine tool base from free vibration studies using an accelerometer pick up with data acquisition system.	**2 Hours**
4	Interface of strain gauge set up to measure strains in a statically loaded machine structure and calibration of the same.	**2 Hours**

5	Interfacing of an LVDT with a PC for monitoring the velocity and acceleration of linear pneumatic actuator with different levels of cylinder cushioning and piston velocities.	**2 Hours**
6	Interfacing the load cell with data acquisition system to measure the applied load and to display the data.	**2 Hours**
7	Interfacing of servo motor with PC for speed and position control of robot.	**2 Hours**
8	Interfacing ADC with PC for converting analog recording data into digital signal which is stored in CD.	**2 Hours**
9	Interfacing DAC with PC to convert digital video data into analog video signals which connect to the screen drivers to display color images.	**3 Hours**
10	Analyzing the frequency spectrum of microphone by interfacing with DAQ for measuring the audio signal	**3 Hours**
11	Design a controller for two wheel self-balancing robot for variable loads.	**3 Hours**
12	Design a controller for controlling the ball on beam in the desired position.	**3 Hours**
13	Measurement of damping ratio of a machine tool base from free vibration studies using an accelerometer pick up with data acquisition system.	**3 Hours**

Total: 30 Hours

References

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI Learning Pvt. Ltd, New Delhi, 2010

18IR21 DESIGN OF MECHANISMS AND MANIPULATORS 3 0 0 3

Course Objectives

1. To design the mechanism for the robot manipulator by applying suitable techniques.
2. To analyse the velocity and dynamics of the robot manipulator.
3. To select the robot for the appropriate applications.

Course Outcomes (COs)

1. Characterize the parameters involved in the manipulator mechanisms.
2. Design and optimize the mechanism for the manipulator using suitable techniques.
3. Analyse the manipulator kinematics for different configuration of robot.
4. Apply various methods for developing the dynamics equations for robot manipulator.
5. Select the robot manipulator for particular application to carry out desired task.

UNIT I **9 Hours**

MECHANISM FOR MANIPULATORS

Mobility analysis - Degrees of Freedom (DOF) - Mixed Mobility - Total, Partial and Fractional DOF - Closed and Open Chain Systems - Manipulators – Classifications - actuation and transmission systems.

UNIT II **9 Hours**

DESIGN OF ROBOT MECHANISM

Structural Analysis and Synthesis of mechanisms - Alternative design solutions - Coding, evaluation and selection of optimum mechanism type synthesis, number synthesis and design of mechanisms. Indexes of merit; Graphical, Algebraic and Optimization techniques - Matrix methods of design and analysis; Design of function, path and motion generators - Structural and mechanical error - Design and Analysis using software.

UNIT III **9 Hours**

MANIPULATOR KINEMATICS

Coordinate transformation - Arm matrix of SCARA – Alpha-II, PUMA articulated robot, polar frame, inverse and forward kinematics – Jacobian – Singularities – Inverse velocity and acceleration.

UNIT IV **9 Hours**

MANIPULATOR DYNAMICS

Newton's and Euler's equation – Closed form dynamic equations – Lagrangian formulation of manipulator dynamics – non rigid body effect.

UNIT V **9 Hours**

MANIPULATOR SELECTION

Selecting of robots for robot application - Reliability of robotic and automation systems and their evaluation.

Total: 45 Hours

FOR FURTHER READING

Kinematic model of the finger and thumb - thumb and fingers pose with respect to palm.

References

1. John J Craig, Introduction to Robotics: Mechanics and Control, Pearson Education, New Delhi, 2017.
2. Gerry B. Andeen, Robot Design Hand Book, SRI International, McGraw Hill Publishers, 1988.
3. M. W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, Wiley, 2005.
4. Venkataraman Subramanian T. and Iberall Thea (Eds.), Dextrous Robot Hands, Springer Publications.
5. AppuKuttan, Robotics, I.K. International Publishing house, New Delhi, 2007.

18IR22 INDUSTRIAL AUTOMATION AND CONTROL 3 0 0 3

Course Objectives

1. Understand the need of automation in various industrial sectors
2. Learn about the various technology developments such as PLC, SCADA and DCS in industrial automation.
3. Understand the basics of communication with its protocol.

Course Outcomes (COs)

1. Outline the different automation functions and its need in automation industries.
2. Characterize the different instructions available in PLC for various applications.
3. Apply knowledge on supervisory control and data acquisition systems.
4. Integrate the distributed control system and to differentiate the DCS over other automation systems.
5. Identify the proper communication buses and its protocol for industrial applications.

UNIT I **9 Hours**

BASICS OF AUTOMATION

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automations-Flow lines, Transfer Mechanisms-Fundamentals and Analysis of Transfer Lines.

UNIT II **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Evolution of PLC-Architecture-Processor Memory Organization: Program Files, Data Files-PLC Programming Languages-PLC Wiring Diagrams and Ladder Logic Programs-PLC Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions-Selection of PLC.

UNIT III **9 Hours**

SUPERVISORY CONTROL AND DATA ACQUISITION

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode functions-Tools: Tag database-Recipe database- Alarm Logging-Trends: Real Time, Historical Trends-Security and User Access Management-Management Information System-Report Function.

UNIT IV **9 Hours**

DISTRIBUTED CONTROL SYSTEM

Evolution of DCS-Types of Architecture-Local Control Unit-Process Interfacing issues-Communication Facilities-Operator and Engineering Interfaces: Low level, High level-Operator Displays.

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction- Communication Hierarchy, Communication System Requirements- Network Topologies-Communication Modes – HART Networks and OSI models- Communication buses-Fieldbus-Modbus-Profibus-Device net- CAN network- System Operation and Troubleshooting.

Total: 45 Hours

FOR FURTHER READING

Automatic Stacking Process-Automatic Control of Warehouse Door-Automatic Bottle Filling-Car Parking System- Pulp and Paper Environment-Petroleum-Refining environment

References

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016.
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2002.
3. Petruzella, FD, "Programmable Logic Controllers", Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009.
5. Lucas M.P, Distributed control systems, Van Nostrand Reinhold Company, Newyork, 1986.
6. Douglas E. Comer, Computer Networks and Internets, Sixth Edition, Prentice Hall, New Delhi, 2015.

18IR23 MACHINE VISION SYSTEM 3 0 0 3

Course Objectives

1. To learn the fundamentals of vision systems
2. To understand the image recognition and retrieval algorithms
3. To learn the concepts of object recognition and applications of vision systems.

Course Outcomes (COs)

1. Identify required machine vision components for given industrial application.
2. Apply required processing techniques for enhancing the image to identify objects.
3. Explain different techniques of object recognition from enhanced image.
4. Use machine vision concept for inspection in manufacturing industries.
5. Explain the interface of vision system to robot operating system.

UNIT I **9 Hours**

BASICS OF MACHINE VISION SYSTEM

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Compute interfaces -Light Sources for Machine Vision-Arrangement of the Lighting: Incident lighting and backlighting

UNIT II **9 Hours**

VISION ALGORITHMS

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

UNIT III **9 Hours**

OBJECT RECOGNITION

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

UNIT IV **9 Hours**

MACHINE VISION IN MANUFACTURING

Types of Tasks: Code recognition, Object recognition, Position recognition, Completeness check, Shape and dimension check, Surface inspection - Environmental Conditions - Industrial Case Studies: Glue Check under UV Light, Completeness Check, Robot Guidance.

UNIT V **9 Hours**

ROBOT VISION

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to Open CV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to Open CV - The CV bridge Package.

Total: 45 Hours

FOR FURTHER READING

Machine learning techniques for object identifications: fuzzy logic and neural network.

References

1. Alexander Hornberg, "Handbook of Machine Vision", WILEY-VCH, 2010.
2. Carsten Steger, Markus Ulrich and Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim, 2008.
3. Damian M Lyons, "Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.
4. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2012.
5. R.Patrick Goebel, "ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.

18IR24 SAFETY IN INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

1. To understand the basic knowledge of the terminologies used in safety and the role of safety in automation
2. To understand the specifications of Automation and also the implementation of safety process
3. To understand the Integrity level of safety in Robotics and automation filed

Course Outcomes (COs)

1. Recognize the basic terminologies relating Safety
2. Exemplify the role of Safety in the field of Automation along with the parameters defining Safety
3. Implement the safety controls for Automation
4. Exemplify the role of Instruments related to Safety
5. Summarize the standards used to determine safety in Robotics

UNIT I **9 Hours**

SAFETY AUTOMATION- AN INTRODUCTION

Origin and History- Definitions and Terminology-Underlying Theories - Assumptions- Use and Implementation- Research Efficiency- Weakness, Limitations and Criticism- Relations to other Safety Principles.

UNIT II **9 Hours**

ROLE OF AUTOMATION IN SAFETY

Process Operations- Plant Automation- Framework for Process Safety- Risk based Design- Risk Management of existing Facility Process Automation Lifecycle- Functional Specification- Designing for operations- Inherently Safer Practices- Designing for Core Attributes- Control and Safety system Integration.

UNIT III **9 Hours**

DESIGN AND IMPLEMENTATION OF SAFETY CONTROLS, ALARMS AND INTERLOCKS:

SCAI Classification- Design Considerations- SCAI Technology Selection- Acceptance Testing- Standards- Factory Acceptance Test- Site Acceptance Test Automation Organization Management- Process Safety Information- Operating Procedures- Maintenance Planning- Human and Systematic Failure Management- Management of Change- Audit, Monitoring and Metrics.

UNIT IV **9 Hours**

SAFETY INSTRUMENTED SYSTEMS (SIS)

Safety instrumentation systems: Hazard and operability studies (HAZOP), Safe Failure Fraction, Safety Instrumented Function SIF, Process Hazards Analysis PHA, Process Hazards Analysis (PHA), Hardware Fault Tolerance, HIPPS (High Integrity Process Pressure System)

UNIT V **9 Hours**

ROBOT & FENCING SAFETY

Introduction to Robot Safety standards - Requirements- Safety Planning- Need for Risk Assessment- Sample Robot Cell-Safeguarding Procedures- Identify Tasks and Hazards- Determination of Risk reduction – Determination of Hazards associated with each task- Safeguard Selection and Validation- Fence Energizer- Permanent and Temporary Electric Fence

Total: 45 Hours

FOR FURTHER READING

Safety Integrated for Factory Automation, Machine Safety, Industrial Automation Safety

References

1. Niklas Maller, Handbook of Safety Principles, Sven Ove Hansson, Jan-Erik, 2018
2. Guidelines for Safe Automation of Chemical Process by Centre for Chemical process Safety, 2016
3. Handbook of Industrial Automation by Richard Shell, 2000
4. Control system safety evaluation and reliability by Williams M. Goble, 2010
5. Safety Instrumented Systems Verification: Practical Probabilistic Calculation by Harry Cheddie, William M. Goble, 2005
6. The Electric Fencing Handbook by Ann Larkin Hansen, 2017

18IR27 ROBOTICS LABORATORY 0 0 2 1

Course Objectives

1. To understand and analyze the different types of robots and their configurations.
2. To acquire knowledge in the concept of programming the SCARA robot.

Course Outcomes (COs)

1. Understand the configuration of industrial robots.
2. Able to develop a program for different operations in SCARA Robot.
3. Implement a motion planning module for the SCARA and articulated robot.

LIST OF EXPERIMENTS

1	Modeling and analysis of different types of robots and their configurations using software.	**3 Hours**
2	Geometric Modeling: SCARA Robot is modeled using an industrial robot simulation system.	**3 Hours**

3	Geometric Modeling: Articulated robot is modeled using an industrial robot simulation system.	**3 Hours**
4	Forward and Inverse Kinematics: The forward and inverse kinematics of SCARA robot have been derived and calculated using simulation software.	**3 Hours**
5	Motion Planning: A small motion planning module for the SCARA and articulated robot has to be implemented which can be checked in the framework of the simulation system.	**3 Hours**
6	Programming the 4 axis articulated robot for pick and place operation	**3 Hours**
7	Programming the 6 axis articulated robot for performing pick and place operation using software and teach pendant.	**3 Hours**
8	Programming the 6 axis articulated robot for drilling application using software and teach pendant.	**3 Hours**
9	Programming the 6 axis articulated robot for palletizing application using software and teach pendant.	**3 Hours**
10	Programming the 6 axis articulated robot for repeated loading and unloading operation using software and teach pendant.	**3 Hours**

Total: 30 Hours

References

1. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2008.
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2016.

18IR31 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

1. To understand the fundamentals of virtual instrumentation, and basic concept of Graphical programming with their functions in LabVIEW.
2. To remember the various types Interfaces and Protocol used in VI
3. To describe the components of typical DAQ and various tools in VI with their application.

Course Outcomes (COs)

1. To represent the fundamentals of virtual Instrumentation and compare conventional with traditional methods.
2. To recognize the concept of graphical programming and LabVIEW with their functions.
3. To identify the types of interfacing devices and protocol used in VI.
4. To describe the functions and the interface requirements in Data acquisition system.
5. To exemplify the types of VI tools with its application.

UNIT I **9 Hours**

INTRODUCTION TO VI

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II **9 Hours**

GRAPHICAL PROGRAMMING

Concepts of graphical programming - LabVIEW software - Concept of VIs and sub VI - Display types - Digital - Analog - Chart and Graphs. Loops - structures - Arrays - Clusters. Local and global variables - String and file I/O. Timers and dialog controls.

UNIT III **9 Hours**

INSTRUMENT INTERFACES AND PROTOCOLS

RS232, RS422, RS485 and USB standards - IEEE 488 standard - Introduction to bus protocols of MOD bus and CAN bus. Electronic standards for signals - noise and EMI effects. Signal conditioning chassis and extension modules. Image acquisition cards and Motion Controllers.

UNIT IV **9 Hours**

DATA ACQUISITION SYSTEM

Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Use of timer-counter and analog outputs on the universal DAQ card.

UNIT V **9 Hours**

VI TOOLS

Mathematical tools for statistical calculation - Signal processing tools- Fourier transforms, power spectrum - Windowing and filtering tools -Control system tools - PID controller – Applications: CRO - function generator -Illustration and case study-Temperature controller.

Total: 45 Hours

FOR FURTHER READING

Simulation of a simple second order system - Controlling motion of servo and stepper motors- Controlling an ice cream-making process- Generation of HTML page.

References

1. Jeffrey Travis, Jim Kring, 'LabVIEW for Everyone: Graphical Programming Made Easy and Fun (3rd Edition), Prentice Hall, 2012.
2. Sanjeev Gupta, 'Virtual Instrumentation using LabVIEW' TMH, 2013.
3. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2011.
4. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2013.
5. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newness, 2010.

DISCIPLINE ELECTIVES

18IR51 COMPUTER INTEGRATED MANUFACTURING 3 0 0 3

Course Objectives

1. To learn the advanced manufacturing techniques.
2. To develop a database for computer aided manufacturing system

Course Outcomes (COs)

1. Describe the role of automation in manufacturing with an aid of computer.
2. Exemplify group technology and its applications in manufacturing systems.
3. Identify the functions of flexible manufacturing system and automatic storage and retrieval system.
4. Describe the company strategies and network management in CIM.
5. Develop a database modelling in manufacturing systems.

UNIT I **9 Hours**

INTRODUCTION

Manufacturing - Types, Manufacturing Systems, CIM Definition, CIM wheel, CIM components, Evolution of CIM, needs of CIM, Benefits of CIM, basic components of NC system, NC motion control system, applications of NC ,advantages and disadvantages of NC, computer Numerical control, advantages of CNC, functions of CNC, Direct Numerical Control, components of a DNC system, functions of DNC, advantages of DNC.

UNIT II **9 Hours**

GROUP TECHNOLOGY AND PROCESS PLANNING

Group technology- role of G.T. in - part families - classification and coding – DCLASS, MICLASS and OPITZ coding systems-facility design using G.T. - benefits of G.T-cellular manufacturing. Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning - variant approach and generative approaches - CAPP and CMPP process planning systems.

UNIT III **9 Hours**

FLEXIBLE MANUFACTURING SYSTEM (FMS)

Components of FMS - types -FMS workstation- - FMS layout –Benefits of FMS- Material handling and storage systems- Automatic storage and retrieval systems-AGVs, Guidance methods -Shop floor control-factory data collection system -automatic identification methods - Bar code technology-automated data collection system- Automatically Programmed Tool.

UNIT IV **9 Hours**

CIM IMPLEMENTATION AND DATA COMMUNICATION

CIM and company strategy - system modelling tools -IDEF models - activity cycle diagram CIM architecture - CIM open system architecture - manufacturing enterprise wheel- Product data management - CIM implementation-software. Communication fundamentals- local area networks topology –LAN implementations –network management and installations, PDM Tools.

UNIT V **9 Hours**

OPEN SYSTEM AND DATABASE FOR CIM

Open system interconnection - Manufacturing Automations Protocol and Technical Office Protocol-Development of databases -database terminology- architecture of database systems-data modelling and data associations -relational data bases - database operators.

Total: 45 Hours

FOR FURTHER READING

Computer aided quality control-Inventory management - Materials requirements planning - basics of JIT.

References

1. P. Radhakrishnan , S. Subramanyan and V.Raju, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi, 2012
2. S. Kant Vajpayee, Principles of Computer Integrated Manufacturing, Prentice Hall of India, 2010.
3. Roger Hanman, Computer Integrated Manufacturing, Addison – Wesley, 2012.
4. Mikell. P.Groover, Automation, Production Systems and computer integrated manufacturing, Prentice Hall of India, New Delhi, 2012.
5. Mikell. P. Groover and Emory Zimmers Jr., CAD/CAM, Prentice Hall of India, New Delhi 2010.

18IR52 INDUSTRIAL DRIVES AND CONTROL 3 0 0 3

Course Objectives

1. To apply the concept of converter and chopper control in dc drives.
2. To develop the closed loop control of AC and DC drives with optimized control
3. To apply the control techniques in drives applications.

Course Outcomes (COs)

1. Analyse the converter and chopper fed DC motor Drives with Braking Schemes.
2. Execute torque versus speed characteristics for cage and wound rotor fed AC drives.
3. Estimate direct and indirect control of Induction motor using flux vector orientation.
4. Analyse the synchronous motor drives with power factor control.
5. Apply the torque - speed control for industrial drives application.

UNIT I **9 Hours**

CONTROL OF DC DRIVES

Analysis of series and separately excited dc motor with single phase and three phase converters - modes of operation, power factor improvement - analysis of series and separately excited dc motor fed from choppers - chopper based implementation of braking schemes.

UNIT II **10 Hours**

CONTROL OF INDUCTION MOTOR DRIVE

Steady state analysis - speed control techniques of induction motor - variable frequency operation of three phase induction motors - constant flux operation - dynamic and regenerative braking of Current Source Inverter (CSI) and Voltage Source Inverter (VSI) fed drives -Torque slip characteristics of wound rotor induction motor - rotor resistance control - static Kramer drive - sub synchronous and super synchronous operation.

UNIT III **8 Hours**

CONTROL AND ESTIMATION

Induction motor-Field oriented control of induction machines - DC drive analogy - Direct and Indirect methods - Flux vector estimation - Direct Torque control strategy of induction machines - Torque expression with stator and rotor flux.

UNIT IV **9 Hours**

SYNCHRONOUS MOTOR DRIVES

Synchronous motor types, open loop VSI fed drive and its characteristics - self-control model - torque angle and margin angle control - power factor control - brushless excitation systems - closed loop control of load commutated inverter fed synchronous motor drive.

UNIT V **9 Hours**

INDUSTRIAL DRIVES AND CONTROL

P, PI and PID controller characteristics - simulation of converter and chopper fed dc drive - Phase locked loop and microcomputer control of dc drives - selection of drives and Control of drives for textile mills, lifts, cranes and hoist drives.

Total: 45 Hours

FOR FURTHER READING

Transfer function of dc motor, closed loop control of induction motor drives, steady state and torque expression of synchronous motors, current and speed loops.

References

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2010.
2. Vedam Subramanyam, Electric Drives: Concepts & Appl, 2/E, New Delhi, Tata McGraw-Hill Education, 2011
3. G.K. Dubey, Power Semiconductor Controlled Drives, New Jersy, Prentice Hall International, 2008.
4. J.M.D. Murphy and Turnbull, Thyristor Control of AC Motors, Pergamon Press, Oxford, 2010.
5. P.C. Sen, Thyristor DC Drives, New York, John Wiely and Sons, 2011.
6. Gopal K. Dubey, Fundamentals of Electrical Drives, New Delhi, 2nd Edition, Narosa Publishing House, 2009.

18IR53 MODERN MANUFACTURING SYSTEM 3 0 0 3

Course Objectives

1. To familiarize in the field of automated machines like computer numerical control.
2. To understand the components and control system of CNC Machines.
3. To develop a computer numerical control program for lathe and milling machines
4. To introduce the concept of 3D printers and Rapid Manufacturing techniques.

Course Outcomes (COs)

1. Describe the principle and constructional features of CNC machine tools.
2. Represent interface the drives, feedback devices and sensors used in CNC machines
3. Create a program to manufacture prismatic components using CNC machining centre.
4. Exemplify the generic steps and classification of Rapid Manufacturing.
5. Identify the suitable process to manufacture the prototype relevant to the application.

UNIT I **9 Hours**

CNC MACHINES AND COMPONENTS

Introduction to Computer Numerical Control: Features of CNC Machines - Factors influencing selection of CNC Machines: Lathe and Vertical Milling Centre -Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axes motors. Timing belts and pulleys, Spindle bearing – Slide ways - Re - circulating ball screws –linear motion guide ways - Tool magazines and ATC.

UNIT II **9 Hours**

CONTROL SYSTEMS, FEED BACK AND SENSING DEVICES

CNC control system - Interpolation systems. Features of CNC system – Introduction to CNC control systems. Types of measuring systems in CNC machines – Incremental and absolute rotary encoders, linear scale – resolver – Linearencoder's – Magnetic Sensors for Spindle Orientation.

UNIT III **9 Hours**

CNC PART PROGRAMMING

Part Program Terminology - G and M Codes – Types of interpolation -Methods of CNC part programming – Manual part programming – Computer Assisted part programming – APT language –- CNC Part program generation using software packages-Introduction to Computer Aided Part Programming.

UNIT IV **9 Hours**

ADDITIVE MANUFACTURING

Need for time compression in product development, Product development – conceptual design – development – detail design – prototype –RP Data Formats - Information flow in a RP system - Generation of STL file- Steps in RP- Factors affecting RP process - Materials for RP - Additive and subtractive Methods - Application in RPT - 3D Printing - Principle and process parameters

UNIT V **9 Hours**

mETHODS OF ADDITIVE MANUFACTURING

Rapid Manufacturing - Stereo lithography, Fusion Deposition Modeling, Laminated object Manufacturing, Solid Ground Curing - Principle - process parameters - Process details - Application.

Total: 45 Hours

FOR FURTHER READING

Applications of RP- RP in Indian scenario - Introduction to rapid tooling – Direct and indirect method

References

1. Yoram Koren, Computer Control of Manufacturing Systems, Tata McGraw-Hill Publishing Company, 2009.
2. 2. Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency, 2013.
3. James Madison, CNC Machining Handbook: Building, Industrial Press, 2011.
4. Mikell P. Groover, Automation Production Systems and Computer Integrated Manufacturing, PHI

Learning Private Ltd, 2016.
5. Frank W Liou, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC press, 2007.
6. C K Chuak, F Leongc and S Lim, Rapid Prototyping, Yes Dee Publishing, 2010.

18IR54 EMBEDDED SYSTEMS 3 0 0 3

Course Objectives

1. To understand the fundamentals of embedded system and the basic concepts of programming
2. To impart knowledge about networks and operating system of embedded systems
3. To study the techniques underlying in building an embedded solution to a wearable, mobile and portable system

Course Outcomes (COs)

1. Identify an embedded system and compare with general purpose System.
2. Understand the various embedded processor and internal memory architecture
3. Know the various Input and output devices and Network protocols
4. Get introduced to RTOS and related mechanisms
5. Choose the Design methodologies for the real time application

UNIT I **8 Hours**

INTRODUCTION TO EMBEDDED SYSTEM

System Design: Definitions - Classifications and brief overview of micro-controllers - Microprocessors and DSPs - Embedded processor architectural definitions - Typical Application scenarios of embedded systems

UNIT II **9 Hours**

PROCESSOR AND MEMORY ORGANIZATION

Bus Organization - Memory Devices and their Characteristics - Instruction Set Architecture [RISC, CISC] - Basic Embedded Processor/Microcontroller Architecture [8051, ARM, DSP, PIC] – Memory system architecture [cache, virtual, MMU and address translation] - DMA, Co-processor and Hardware Accelerators - Pipelining

UNIT III **10 Hours**

I/O DEVICES AND NETWORKS

I/O Devices[Timers, Counters, Interrupt Controllers, DMA Controllers, A/D and D/A Converters, Displays, Keyboards, Infrared devices] - Memory Interfacing - I/O Device Interfacing [GPIB, FIREWIRE, USB, IRDA] - Networks for Embedded systems (CAN, I2C, SPI, USB, RS485, RS 232) -Wireless Applications [Bluetooth, Zigbee].

UNIT IV **9 Hours**

OPERATING SYSTEMS

Basic Features of an Operating System - Kernel Features [polled loop system, interrupt driven system, multi rate system] - Processes and Threads - Context Switching - Scheduling[RMA, EDF, fault tolerant scheduling] - Inter-process Communication - Real Time memory management [process stack management, dynamic allocation] - I/O[synchronous and asynchronous I/O, Interrupts Handling, Device drivers] - RTOS [VxWorks, RT-LINUX].

UNIT V **9 Hours**

EMBEDDED SYSTEM DEVELOPMENT

Design Methodologies [UML as Design tool, UML notation, Requirement Analysis and Use case Modeling] - Design Examples [Telephone PBX, Inkjet Printer, PDA, Elevator Control System, ATM System] - Fault-tolerance Techniques - Reliability Evaluation Techniques.

Total: 45 Hours

FOR FURTHER READING

Discussion of specific examples of complete embedded systems using mc68 HC11, mc8051, ADSP2181, Arduino microcontroller, Raspberry Pi, PIC series of microcontroller

References

1. Wayne Wolf, Computers as components: Principles of Embedded Computing System. design The Morgan Kaufmann Series in Computer Architecture and Design, 2008
2. Jane W. S., Liu, Real time systems, Pearson Education, 2010
3. Raj Kamal, Embedded systems Architecture, Programming and design, Second Edition, 2013
4. Robert Ashby, Designer's Guide to the Cypress PSoC Newnes, 2015
5. Microblaze processor Reference guide, Xilinx
6. NIOS II Processor reference Handbook, ALTERA

18IR55 BASICS OF ELECTRICAL & ELECTRONIC ENGINEERING 3 0 0 3

Course Objectives

1. To create basic knowledge in the area of electronics for the mechanical discipline students
2. To understand the basic characteristics of electronic devices
3. To enhance the knowledge of the students in the area of integrated circuits and power electronics

Course Outcomes (COs)

1. Exemplify the basic concepts of electric circuits.
2. Classify the DC and AC machines and explain their operation.
3. Interpret the operation of electronic devices
4. Illustrate the characteristics of semiconductor devices
5. Elucidate the working of rectifiers and choppers

UNIT I **9 Hours**

ELECTRIC CIRCUITS ELECTRIC CIRCUIT

Definition of Voltage, Current, Power & Energy, Ohm's law, Kirchhoff's Law & its applications – simple problems, division of current in series & parallel circuits, generation of alternating EMF, definition of RMS value, average value, peak factor, and form factor. Power in single phase AC – three phase system. Star to delta and delta to star transformations

UNIT II **9 Hours**

ELECTRICAL MOTORS

Constructional details, principle of operation and performance characteristics of D.C. motors & A.C. motors, single phase induction motor, three phase induction motor, synchronous motors, universal motors, stepper motors, Synchronous motors and reluctance motor.

UNIT III **9 Hours**

ELECTRONIC COMPONENTS AND AMPLIFIERS

Passive components - Intrinsic and Extrinsic semiconductors - PN Junction diodes and its applications - Special purpose diodes: Zener diode –Photodiode - Bipolar Junction Transistor: CE, CB, CC Configurations - Operational amplifier (op-amp) – Characteristics - Arithmetic operations using op-amp - Applications: Instrumentation amplifier, Sample and Hold circuits

UNIT IV **9 Hours**

POWER SEMI-CONDUCTOR DEVICES

Thyristor families: Silicon Controlled Rectifier, Diode AC Switch, Triode AC switch, Metal Oxide Semiconductor Field-effect Transistor, Insulated Gate Bipolar Transistor, Light Activated Silicon Controlled Rectifier - Operating mechanism, characteristics and applications

UNIT V **9 Hours**

POWER ELECTRONIC CIRCUITS

Phase controlled Rectifier: Single phase and Three phase controlled and uncontrolled rectifiers with R and RL load – Chopper: Time Ratio Control, Types, Four Quadrant operation – Voltage Source Inverter – Current Source Inverter - Regulated power supply design

Total: 45 Hours

FOR FURTHER READING

Resonant Pulse Converters and Cyclo converters

References

1. R. Muthusubramaninan, S. Salivahanan and K. A. Muraleedharan, Basic Electrical, Electronics and Computer Engineering, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.
2. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford Press, 2012.
3. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2013.
4. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Prentice Hall of India Learning. Ltd., New Delhi, 2011.
5. M. D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
6. P. S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi, 2012.

18IR56 FIELD AND SERVICE ROBOTS 3 0 0 3

Course Objectives

1. Interpolate the various types of robots and its specifications
2. Assess the forward kinematics and inverse kinematics of robots.
3. Represent the control of robots for different applications.

Course Outcomes (COs)

1. Summarise the history, needs and types of robots in various sectors
2. Identify the localization of robot in any dynamic environment
3. Analyse the shortest path for mobile robots
4. Classify the robots based on their application
5. Exemplify the concepts of Humanoid Robots and also its functions

UNIT I **9 Hours**

INTRODUCTION

History of service robotics – Present status and future trends – Need for service robots - applications- Classification of service and field Robots, specifications and examples. Non-conventional Industrial robots.

UNIT II **9 Hours**

LOCALIZATION

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization-Monte Carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems-Route based localization.

UNIT III **9 Hours**

PLANNING AND NAVIGATION

Introduction-Path planning overview- Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance - Case studies: tiered robot architectures.

UNIT IV **9 Hours**

ROBOT APPLICATIONS

Aerial robots - Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications. Automatic and remote Guided Vehicle

UNIT V **9 Hours**

HUMANOIDS

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing.

Total: 45 Hours

FOR FURTHER READING

Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies

References

1. Roland Siegward, Illah Reza Nourbaksh and Davide Scaramuzza, "Introduction to Autonomous Mobil Robots", Bradford Company Scituate, USA 2010.
2. Raidh Siaer, "The future of Humanoid Robots – Research and applications", Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentics Hall of India P Ltd, 2015.
4. Kelly Alonzo, Iagnemma Karl and Howard Andres, "Field and Service Robotics", Springer, 2017

18IR57 MODERN MATERIAL HANDLING SYSTEMS 3 0 0 3

Course Objectives

1. To understand the latest material handling system used in industry.
2. To study about the concept of Automated Guided Vehicle System

Course Outcomes (COs)

1. Recognize the basics of material handling systems and equipment.
2. Demonstrate knowledge on various material handling equipment used both in automated and non-automated systems.
3. Interpret the basic components and the functions of Automated Guided Vehicle system.
4. Exemplify the types, controls and features of Automated Storage System.
5. Identify the general considerations of Robot Material Handling and its industrial application.

UNIT I **9 Hours**

FUNDAMENTALS OF MATERIAL HANDLING

Material Handling – Functions, Types, analysis, Importance & Scope, Principles, - Part feeding device – types of material handling system – Unit material movement & Unit loads – Receiving, Shipping, in process handling – bulk handling equipment & methods.

UNIT II **9 Hours**

MATERIAL HANDLING EQUIPMENT

Industrial trucks, lifting device, monorails, manipulators, conveyors, storage systems, elevators, racks, bins, pallets, cranes – Automation of material handling – mechanization of part handling.

UNIT III **9 Hours**

AUTOMATED GUIDED VEHICLE SYSTEM

Types of AGV's – Guidance techniques – Painted line, wire guided, and vision guided method – Applications – Vehicle guidance & routing – Traffic control & safety – system management – Quantitative analysis of AGV system.

UNIT IV **9 Hours**

STORAGE SYSTEM

Conveyor systems – types, Quantitative relationship & analysis – Automated storage system, performance – AS/RS system – Basic components, types, controls, features, applications, Quantitative analysis – carousel storage system – applications.

UNIT V **9 Hours**

ROBOTICS IN MATERIAL HANDLING

General considerations in robot material handling – material transfer application – pick & place operations – machine loading & unloading – characteristics of robot application.

Total: 45 Hours

FOR FURTHER READING

Methods of protecting materials for packages - auxiliary equipment's -automated identifications Systems.

References

1. Mikell P. Groover, Automation Production Systems and Computer Integrated Manufacturing, PHI Learning Private Ltd, 2008.
2. Mikell P Groover, Mitchel Weiss and Ashish Dutta, Industrial Robotics, McGraw Hill Publications, 2017.
3. Material Handling Handbook, Institution of Mechanical Engg. Associate (data) Publishers P Ltd, 1996.
4. C Ray Asfahl, Robots and Manufacturing Automation, Wiley India, 2012.
5. Charles D Reese, Taylor and Francis Material Handling Systems, 2000.

18IR58 MICRO ELECTRO MECHANICAL SYSTEM 3 0 0 3

Course Objectives

1. To recognize application of Microsystems and difficulties in miniaturization
2. To explain the working principle of several micro sensors and micro actuators
3. To attribute the properties of engineering materials for MEMS devices
4. To exemplify advanced techniques of micro manufacturing, design and packaging

Course Outcomes (COs)

1. Retrieve the scaling laws that are used extensively in the conceptual design of micro devices and able to select materials for common micro components and devices
2. Summarize the working principles of micro sensors and actuators used in Microsystems
3. Justify a suitable machining technique for a specific microsystem and its application
4. Justify a suitable manufacturing technique for a specific microsystem
5. Outline microsystem packaging and design

UNIT I **9 Hours**

MICRO SYSTEMS AND MINIATURIZATION

Micro systems and microelectronics - Applications of micro system in automotive – bio medical – aerospace - telecommunication industries. Micro pressure sensors, MEMS switches/resonators, MEMS reliability. Optical MEMS devices. Trimmer's scaling vector and scaling laws - scaling in geometry – scaling in rigid body dynamics– scaling in electrostatic forces – scaling in electricity - scaling in fluid mechanics – scaling in heat transfer.

UNIT II **9 Hours**

MICRO SENSORS AND MICRO ACTUATORS

Micro sensors – Types of micro sensors – Micro accelerometer, Acoustic wave sensor, Biomedical sensors and Biosensors, Chemical sensors, Optical sensors, Pressure sensors and thermal sensors. Micro actuation techniques – piezoelectric crystals – Shape memory alloys – bimetallic - conductive polymers. Micro motors –

micro grippers - Microfluidic devices - Micro pumps – mechanical and non-mechanical micro pumps - micro valves – valve less micro pumps – Lab on Chip

UNIT III **9 Hours**

MATERIALS AND FABRICATION PROCESSES

Materials for MEMS: Substrates and wafer, Silicon as a MEMS material – Crystal structure of silicon – Miller indices - single crystal silicon wafer formation – ideal substrates – mechanical properties. Silicon compounds – SiO_2, SiC, Si_3N_4 and polycrystalline silicon – silicon piezo-resistors - Gallium arsenide - polymers for MEMS – quartz. Use of gold and other metals in MEMS. Fabrication processes: Photolithography, Ion implantation, Diffusion – oxidation – chemical vapor deposition – physical vapor deposition – deposition by epitaxy

UNIT IV **9 Hours**

MICROMANUFACTURING

Clean room technology - Processes for bulk micro machining – Wet vs dry etching - Chemical etching of Silicon – etchant systems and etching process – Reactive ion etching and DRIE - mask layout design. Processes for Surface micromachining –Limitations of Bulk and surface micromachining – LIGA, SLIGA and other micro molding processes such as HeXIL

UNIT V **9 Hours**

MICROSYSTEMS DESIGN AND PACKAGING

Design Considerations- design constraints, selection of materials, manufacturing, signal transduction, electro mechanical system, packaging, Process design – Photolithography, Thin film fabrication, Geometry shaping, Mechanical design – thermo mechanical loading, thermo mechanical stress analysis, dynamic analysis and interfacial fracture analysis. Micro system packaging: Materials die level, device level – system level – packaging techniques – die preparation – surface bonding – wire bonding – sealing.

Total: 45 Hours

FOR FURTHER READING

Case studies. Capillary Electrophoresis network system – Computer aided design for Microsystems-Pressure Sensor packaging.

References

1. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press Publishers, India, 2014.
2. Tai Ran Hsu, MEMS and Micro Systems Design and Manufacture, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2016.
3. Nadim Maluf, an Introduction to Micro Electro Mechanical System Design, Artech House Publishers, London, 2013.
4. Chang Liu, Foundations of MEMS, Pearson Education, New Delhi, 2011.
5. Julian w. Gardner, Vijay K. Varadan and Osama O. Awadelkarim, Micro sensors MEMS and smart Devices.
6. E.H. Tay, Francis and W.O.Choong, Microfluids and Bio MEMS applications, Springer, 2017.

18IR59 ARTIFICIAL INTELLIGENCE **3 0 0 3**

Course Objectives

1. To understand the basic concepts of artificial intelligence
2. To Utilize various search and matching techniques used in artificial intelligence
3. To develop the problem solving skill using AI

Course Outcomes (COs)

1. Summarize the basic concepts of artificial intelligence.
2. Identify and use various search and matching techniques used in artificial intelligence.
3. Elucidate the knowledge organization and Representation of structures.
4. Illustrate Fuzzy logic principles and applications.
5. Apprehend basic concepts of machine learning.

UNIT I **9 Hours**

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

History, Definition of AI and Emulation of human cognitive process- Agents: types- An abstract view of modelling and Elementary knowledge- Computational and Predicate logic- Analysis of compound statements using simple logic connectives- Nature of Environments.

UNIT II **9 Hours**

PROBLEM SOLVING AGENTS

Problem Definition, Formulating problems and Searching for solutions- Examples using production rules- Search/Strategies: Uninformed or Blinded search and Breadth first search- Uniform cost search: Depth first search, Depth limited search- Iterative deepening, Depth first search and Bi – directional search- Comparing uniformed search strategies and Informed search strategies- Heuristic information and Hill climbing methods- Best First Search; Greedy Best First Search, Branch-and Bound Search.

UNIT III **9 Hours**

KNOWLEDGE ORGANISATION AND COMMUNICATION

Knowledge organization, manipulation and acquisition- Indexing and Retrieval techniques and Integration of knowledge in memory organization systems- Matching Techniques: Need for matching and simple Matching problems- Partial matching, Fuzzy matching and RETE matching algorithm- Perception- Natural language: Overview of linguistics and Basic semantic analysis - Representation structures and Natural language generation- Uncertainty- Bayesian Networks and Bayesian Inference.

UNIT IV **9 Hours**

INTELLIGENCE SYSTEM

Handling uncertainty and learning: Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions.

UNIT V **9 Hours**

MACHINE LEARNING

Basic concepts, linear models, perceptron, K nearest neighbours, advanced models, neural networks, SVMs, decision trees and unsupervised learning, Markov decision processes and reinforcement learning, Logical Agent, propositional logic and first order logic.

Total: 45 Hours

FOR FURTHER READING

Self-driving cars, Face recognition, Web search, Industrial robots, Missile guidance

References

1. Deepak Khemani, "A First Course in Artificial Intelligence", Tata McGraw Hill Publications, 2013.
2. S. Russel and P.Norvig,"AI: A modern approach", Pearson Education, 3rd Edition, 2009.
3. Eugene Charniak and Drew McDermot, “Introduction to Artificial Intelligence”, Addison Wesley Longman Inc., 2016.
4. Elaine Rich and Kelvin Knight, “Artificial Intelligence”, Tata McGraw Hill Publications, New Delhi, 2011.
5. Schalkoff, R.J., “Artificial Intelligence: An Engineering Approach”, Tata McGraw-Hill Publications, 2012.

18IR60 FINITE ELEMENT ANALYSIS 3 0 0 3

Course Objectives

1. To impart knowledge on finite element procedures of one, two dimensional and iso- parametric elements to solve structural related problems.
2. To understand the procedures of finite element methods to solve fluid, heat transfer and vibration field problems.

Course Outcomes (COs)

1. Apply finite element methods for one dimensional element.
2. Execute the finite element methods for two dimensional elements.
3. Compare and contrast various node elements in an application.
4. Analyse fluid flow and heat transfer for suitable application.
5. Evaluate dynamic and plate application.

UNIT I **9 Hours**

ONE DIMENSIONAL ELEMENTS

Relevance of finite element analysis in design-FEM procedure-Modelling and discretization, Interpolation, elements, nodes, coordinate system and Degrees-of-Freedom - Applications of FEA. Bar, beam, Truss and Frame elements, stiffness matrices, Assembly matrix, Boundary conditions, Solution-Application problems.

UNIT II **9 Hours**

TWO DIMENSIONAL ELEMENTS

Plane Stress and Strain-Constant strain triangular elements (CST) -Linear strain triangular elements (LST) - Bilinear and Rectangular elements-Tetrahedron, hexahedral and Axisymmetric Elements

UNIT III **9 Hours**

ISO-PARAMETRIC ELEMENTS

Introduction-Iso-parametric three, four, eight and nine node elements - Bilinear elements-Lagrange polynomial shape function, Jacobian matrix, strain- displacement matrix, stress-strain relationship matrix, stiffness matrix Applications

UNIT IV **9 Hours**

FLUID FLOW AND HEAT TRANSFER ANALYSIS

Finite element formulated equations of basic flow problems - One dimensional fluid flow Finite element formulation - problem. Formulation of two dimensional heat transfer linear triangular elements problems.

UNIT V **9 Hours**

DYNAMIC AND PLATE ANALYSIS

Dynamic equations-Consistent and lumped mass matrices-one dimensional element - stiffness, mass and force matrices - Introduction to thin plate theory, Finite triangular plate - stiffness matrix Jacobian matrix -shell element- Grid sensitivity test.

Total: 45 Hours

FOR FURTHER READING

Non -linear analysis, Solution Techniques-Case studies-h and p elements formulation

References

1. D. L .Logan, A First Course in the Finite Element Method, Cengage Learning, 2012.Education, New Delhi, 2015.
2. S. S. Bhavikati, Finite Element Analysis, New Age International Publishers, 2016
3. S. S. Rao, The Finite Element Method in Engineering. Elsevier Publishers, 2014
4. J. N. Reddy, AnIntroduction to the Finite Element Method, Tata McGraw Hill International,2009
5. J. Ramachandran, Boundary and Finite Element Theory and Problems, Narosa Publishing House, 2000.
6. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill, 2012.

18IR61 SMART MATERIALS 3 0 0 3

Course Objectives

1. To learn the various material properties and structures based on industrial application.
2. To acquire knowledge on shape memory alloys and its application.

Course Outcomes (COs)

1. Select the materials for suitable application.
2. Analyze the smart material structures and implement the materials based on industrial application.
3. Characterize the smart material using electro rheological fluids.
4. Identify the Properties of commercial piezoelectric materials.
5. Analyze the shape memory alloy for Satellite antenna applications.

UNIT I **9 Hours**

INTRODUCTION AND HISTORICAL PERSPECTIVE

Classes of materials and their usage – Intelligent /Smart materials – Evaluation of materials Science – Structural material – Functional materials – Poly functional materials – Generation of smart materials – Diverse areas of intelligent materials – Primitive functions of intelligent materials – Intelligent inherent in materials – Examples of intelligent materials, structural materials, Electrical materials, biocompatible Materials etc.–Intelligent biological materials – Biomimetics – Wolff's law – Technological applications of Intelligent materials.

UNIT II **9 Hours**

SMART MATERIALS AND STRUCTURAL SYSTEMS

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – An algorithm for synthesizing a smart material – Passive sensory smart structures–Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.

UNIT III **9 Hours**

ELECTRO-RHEOLOGICAL (FLUIDS) SMART MATERIALS

Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase – Electro-rheological fluid domain – Electrorheological fluid actuators – Electro-rheological fluid design parameter – Applications of Electrorheolgoical fluids.

UNIT IV **9 Hours**

PIEZOELECTRIC SMART MATERIALS

Background – Electrostriction – Pyroelectricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters.

UNIT V **9 Hours**

SHAPE MEMORY ALLOYS

Background on shape – memory alloys (SMA) Nickel – Titanium alloy (Nitinol)- Materials characteristics of Nitinol – Martensitic transformations Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robot actuated by SMA – SMA memorisation process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – primary molding – secondary moulding – Potential applications of SMA plastics.

Total: 45 Hours

FOR FURTHER READING

Applications of smart materials in Aerospace, Mass transit, Automotive and Medical.

References

1. M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 2012.
2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects of Shape Memory alloys, Butterworth –Heinemann, 2013.
3. C.A.Rogers, Smart Materials, Structures and Mathematical issues, Technomic Publising Co., USA, 2014.
4. Performance Modeling of Automated Manufacturing Systems, - Viswanandham, PHI, 2nd edition, 2016.
5. Gowda Annappa Dayananda Application of DCS in Sugar Plant Automation, LAP Lambert Academic Publishing AG & Co KG, 2012.
6. M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 2012.

18IR62 INDUSTRIAL DATA NETWORKS 3 0 0 3

Course Objectives

1. To learn about industrial data communication protocol
2. To understand wireless connecting devices such as Bluetooth module, WiFi module and Zigbee applications

Course Outcomes (COs)

1. To infer the basic data networks like ISO-OSI model and TCP/IP protocols
2. To analyze the concepts of inter-networking and serial communication
3. To extrapolate the communication protocol devices such as HART and Field buses and its architecture & Topologies
4. To select the MODBUS & Profibus communication models and its troubleshooting techniques and applications
5. To implement the Industrial Ethernet and Wireless communication in radio communication

UNIT I **9 Hours**

DATA NETWORK FUNDAMENTALS

Network hierarchy and switching – Open System Interconnection model of ISO– Data link control protocol: - HDLC – Media access protocol – Command/response – Token passing – CSMA/CD, TCP/IP.

UNIT II **9 Hours**

CONNECTORS

Bridges – Routers – Gateways –Standard ETHERNET and ARCNET configuration special requirement for networks used for control.

UNIT III **9 Hours**

HART AND FIELDBUS

Introduction- Evolution of signal standard – HART communication protocol –Communication modes – HART networks – HART commands – HART applications. Fieldbus: – Introduction – General Fieldbus architecture – Basic requirements of Field bus standard – Fieldbus topology – Interoperability – Interchangeability – Introduction to OLE for process control (OPC).

UNIT IV **9 Hours**

MODBUS AND PROFIBUS PA/DP/FMS AND FF

Modbus protocol structure – function codes – troubleshooting Profibus: Introduction –profibus protocol stack – profibus communication model – communication objects – system operation – troubleshooting – review of foundation field bus.

UNIT V **9 Hours**

INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION:

Industrial Ethernet: Introduction – 10Mbps Ethernet, 100Mbps Ethernet. Radio and wireless communication: Introduction – components of radio link – the radio spectrum and frequency allocation – radio modems

Total: 45 Hours

FOR FURTHER READING

Applications of wireless communication: Zigbee, WiFi, GPS

References

1. CSteve Mackay, Edwin Wrijut, Deon Reynders, John Park, 'Practical Industrial Data networks Design, Installation and Troubleshooting', Newnes publication, Elsevier First edition, 2015.
2. William Buchanan "Computer Buses", CRC Press, 2010.
3. Andrew S. Tanenbaum, Modern Operating Systems, Prentice Hall of India Pvt, LTD, 2013.
4. Theodore S Rappaport, "Wireless Communication: Principles & Practice", Prentice Hall of India. 2nd Edition, 2017
5. William Stallings, "Wireless Communication & Networks", Prentice Hall of India, 2nd Edition, 2015.

18IR63 PROCESS CONSULTING AND PROJECT PLANNING 3 0 0 3

Course Objectives

1. To understand basic foundation in project management methodologies, approaches, and process
2. To understand the different roles associated with project management
3. To acquire knowledge on the key tools and techniques used in project management.

Course Outcomes (COs)

1. To summarize project contract and summarize the types of projects and contracts.
2. To exemplify planning and identify the steps involved in planning.
3. To implement documentation for a given project using the documentation software.
4. To compare the various purchase related activities ranging from material ordering to testing
5. To explain the various phases involved in project management and illustrate project evaluation techniques such as pert/cpm.

UNIT I **9 Hours**

INTRODUCTION

Definition of project, purpose, scope, time, quality and organization structure, project structures and contract types. Basic and detailed engineering: degree of automation, graphical project management tools for lanning, controlling, analysing and forecasting project's status, progress, performance (project s curves), manpower considerations, and inter-department and inter organization interactions, multi-agency interaction. Types of projects and types of contracts e.g. epc, boot etc.

UNIT II **9 Hours**

PROJECT -PLANNING

Planning - Customer expectations and performance criterion, User Requirement Specifications (URS), Functional Design Specifications (FDS), Software Requirement Specifications and Hardware Requirement Specifications (SRS and HRS), international standards and practices, consultant requirements. Automation – role, selection criterion for equipment. Project execution steps. Instrumentation audit, plant layout, plans and elevation.

UNIT III **9 Hours**

PROJECT DOCUMENTATION

Design and documentation - process function diagrams and interlock, interface diagrams, process flow diagrams, P&ID, loop wiring diagrams, ladder diagrams, isometrics, installation detail drawing, control console. Control panel drawings, document control, checklists, legend sheets, instrument catalogues, test and progress reports, documentation software documents and version control

UNIT IV **9 Hours**

PURCHASE ACTIVITIES

Purchase-vendor registration, tendering and bidding process, bid evaluation, purchase orders, and reports erection and commissioning - site conditions and planning, installation and documentation. Test and trial – installation sketches, bill of material, quantity surveying, Factory Acceptance Test (FAT), On-Site Inspection and Testing (SAT) installation sketches, cold commissioning and hot commissioning, CAT (Customer Acceptance Test), performance trials and final hand-over.

UNIT V **9 Hours**

PROJECT MANAGEMENT

Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. Project planning and scheduling, life cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle. Cost and estimation: Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. Program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software's used in project management.

Total: 45 Hours

FOR FURTHER READING

The Basic Project Management Process, Project Management Consulting

References

1. Harlod Kerzner Van Nostrand. Project management: "A systems approach to planning Scheduling and Controlling" Reinhold publishing.
2. FREDRICK S.Hiller and Gerald J. Lieberman "Introduction to Operations Research", Tata McGraw Hill, New Delhi, 2017.
3. Graham D.Vinter, Gareth Pierce, Project Finance, New Delhi: Thomson, 2012.
4. Richman Larry, Project Management: Step by Step, New Delhi: Prentice Hall, 2009.
5. Willie Tan, Principles of Project and Infrastructure Finance, Taylor & Francis, 2011

18IR64 ROBOT ECONOMICS 3 0 0 3

Course Objectives

1. Interpret the knowledge of the fundamental and technical concepts of robot economics.
2. Apply the basic laws of robotics in the development of artificial intelligence robot and demonstrate a sense of responsibility and a capacity for service.
3. Identify and use economics terminologies in robot and will demonstrate an awareness of their role in the global economics environment.

Course Outcomes (COs)

1. Select a suitable component to construct the robot and study its characteristics.
2. Analyze the robot based on the economic concepts and increase the productivity.
3. Implement the robotics in the specific application to reduce man power.
4. Interpret the safety aspects of robot and its handling in different issues.
5. Create an application using robot in real world process.

UNIT I **9 Hours**

INTRODUCTION

Type of Robot Installation - Cost Data Required for the Analysis - Investment Costs- Operating Costs - Life Cycle of Cash Flow - Methods of Economic Analysis - Payback Method, Equivalent Uniform Annual Cost Method, Return on Investment Method.

UNIT II **9 Hours**

ECONOMIC ANALYSIS FOR ROBOTICS

Economic analysis for robotics- Economic analysis- basic data- methods of Economic analysis- subsequent uses of robot-Difference in production rates-other factors Robot project analysis form.

UNIT III **9 Hours**

IMPLEMENTING ROBOTICS

Familiarization with robotics technology- plant survey to identify potential applications- Selection of the best applications- Selection of a robot- Detailed economic analysis, planning and installation.

UNIT IV **9 Hours**

SOCIAL ISSUES

Robotics and labour - Development and Globalization - Economics and Regulation - Education - Energy and Environment - Health and Medicine - Intellectual Property Internet, Communications and Media - Investing and Ownership Society, international impacts, future applications.

UNIT V **9 Hours**

ECONOMICS OF ROBOT CELL LAYOUTS

Economic analysis of robot cell - Multiple Robots and Machine Interface - Some Consideration in Work Cell Design - Interlocks, - Error Detection and Recovery - Robot Cycle Time Analysis – Economy, Development.

Total: 45 Hours

FOR FURTHER READING

Economics of Humanoid Robot using Artificial Intelligence, Robot Economy for applications of nuclear weapon handling, Furnace handling robots.

References

1. Mikell P. Groover, Mitchell weiss, Roger N. Nagel and Nicholas G.Odrey, Industrial Robotics, technology programming and Applications, 2016.
2. Richard D. Klafter, Thomas. A, Chrielewski, Michael Negin, Robotics Engineering an Integrated Approach, Prentice Hall of India Pvt. Ltd., 2014.
3. P. Radhakrishnan, R. Srivatsavan, P.V. Mohan Ram and R. Radharamanan, CAD/CAM, Robotics and factories of the future, Proceeding of the 14th International Conference on CAR and FOF '98 editors, Narosa Publishing house, 2010.
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, McGraw Hill Book Publications.

18IR65 INTELLIGENT SYSTEMS 3 0 0 3

Course Objectives

1. To develop the mathematical model for the non-linear control systems.
2. To acquire knowledge on neural networks, fuzzy logic and deep learning techniques used in robotic system.
3. To develop and analyse the various control algorithm applied for the control of robotic system

Course Outcomes (COs)

1. Develop a mathematical model for a non-linear system using control algorithms.
2. Characterize and compare the neural network and fuzzy logic control for system identification.
3. Analyse the SISO and MIMO system using adaptive control techniques.
4. Apply the deep learning concepts in intelligent control of robotic system.
5. Examine the intelligent control techniques applied for the real time applications.

UNIT I **9 Hours**

NON-LINEAR CONTROL

Continuous - time State-space Model – Nonlinear state-space model – Lyapunov stability theory – Discrete-time systems – Modeling of different nonlinear systems: Inertial wheel pendulum, two link manipulator, and inverted pendulum – nonlinear control strategies.

UNIT II **9 Hours**

NEURAL NETWORKS

Feed-Forward Networks - Multi-layered Neural Networks - Adaptive Learning Rate - System Identification Using Neural Networks - Fuzzy Logic: Classical sets - Fuzzy Sets - Fuzzy Rule Base and Approximate Reasoning - Fuzzy Logic Control - System Identification Using T-S Fuzzy Models.

UNIT III **9 Hours**

INDIRECT ADAPTIVE CONTROL USING NEURAL NETWORKS

Continuous Time Affine Systems - Discrete Time Affine Systems - Direct Adaptive Control Using Neural Networks - Direct Adaptive Control - Single Input Single Output Affine Systems - Multi Input Multi Output Systems - Back-stepping Control - Back-stepping Control for A Robot Manipulator - Intelligent Control of a Pendulum on a Cart - Network Inversion Based Control.

UNIT IV **9 Hours**

DEEP LEARNING

Learning algorithms–Gradient-based learning-Regularization of deep learning: Parameter norm penalties–Dataset augmentation–Noise robustness-Semi-supervised learning–Multitask learning-Early stopping–Sparse representation–Bagging and dropout - Adversarial training– Optimization for training deep models.

UNIT V **9 Hours**

CASE STUDIES AND APPLICATIONS

Dynamics-based control of robotic manipulators – Force-feedback control in robotics tasks –Fuzzy PI Controller for a Series DC Motor - Intelligent robot operating system for nuclear power plant, Hospital environment and military applications - Intelligent robotics for space applications.

Total: 45 Hours

FOR FURTHER READING

Robot economics and safety, Robot integration with CAD/CAM/CIM, Collision free motion planning

References

1. Laxmidhar Behera, Indrani Kar, Intelligent systems and control: principles and applications, Oxford University Press, 2010.
2. D. Katic, M. Vukobratovic, Intelligent Control of Robotic Systems, Springer Publishers, First Edition 2003.

3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.
4. Kimon P. Valavanis and George N. Saridis, Intelligent Robotic Systems: Theory, Design and Applications, Springer Publishers, First Edition, 2012.
5. Tzafestas, Intelligent Robotic Systems, CRC Press, Second Edition, 2012.
6. Li Min Fu, Neural networks in Computer intelligence, TMH, 2003.
7. James A, Freeman David M S, Kapura, Neural networks, Pearson education, 2004.

18IR66 CONTROL SYSTEM 3 0 0 3

Course Objectives

1. To develop linear models mainly state variable model and Transfer function model from Non Linear systems.
2. To analyze linear systems in time domain and frequency domain with application of mathematics, science and engineering
3. To emphasize the importance of drive based control and its related terminologies

Course Outcomes (COs)

1. Design physical systems using transfer function techniques.
2. Apply the theory and practices of time domain analysis.
3. Evaluate the response of the system using frequency domain analysis.
4. Examine the stability of the system with phase and gain margin.
5. Design the controller using root locus and state space analysis.

UNIT I **9 Hours**

INTRODUCTION

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function- Modeling of physical systems – Mechanical and Thermal systems Electric Networks -Transfer function of DC generator, - Block diagram reduction techniques, Signal flow graph – Mason's gain formula.

UNIT II **9 Hours**

TIME DOMAIN ANALYSIS

Standard Test signals – Time response of second order system - Time domain specifications – Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feedback control.

UNIT III **9 Hours**

FREQUENCY DOMAIN ANALYSIS

Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot– All pass minimum phase and non-minimum phase systems.

UNIT IV **9 Hours**

SYSTEM STABILITY

Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability -Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin.

UNIT V **9 Hours**

STATE SPACE ANALYSIS

Root locus concepts - Construction of root loci – Root contours. State Space Analysis: Limitations of conventional control theory - Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical systems - Phase and canonical variables.

Total: 45 Hours

FOR FURTHER READING

Tutorials Using MATLAB/ Simulink – Toolboxes & Functions. Design Specification and Tuning of PID controller

References

1. Norman Nise S, “Control system Engineering“, John Wiley & Sons, New Delhi, 2013.
2. Nagrath I J, and Gopal, M, 'Control Systems Engineering” Prentice Hall of India, New Delhi, 2017.
3. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2012
4. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2010.
5. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2013.

18IR67 RESEARCH METHODOLOGY AND IPR 3 0 0 3

Course Objectives

1. To learn various research problem formulation methods.
2. To understand the research analysis concepts and research ethics.
3. To impart the knowledge on the hypotheses testing process and its methods
4. To understand importance of Intellectual Property Right.
5. To learn about procedures of IPR protection for inventors

Course Outcomes (COs)

1. Formulate the research problem using specific methods.
2. Analyze research related information and Follow research ethics.
3. Explain the Hypotheses Testing process and its methods.
4. Describe the important role of in growth of individuals & nation
5. Explain the significance of patent rights and patent administration systems.

UNIT I **9 Hours**

INTRODUCTION

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation and necessary instrumentation.

UNIT II **9 Hours**

LITERATURE STUDIES AND TECHNICAL WRITING

Effective literature studies approaches, analysis Plagiarism and Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III **9 Hours**

HYPOTHESES TESTING

Testing of hypotheses concerning means -one mean and difference between two means -one tailed and two tailed tests, t-test, cluster, factor and discriminant analysis, variance -one tailed Chi-square test.

UNIT IV **9 Hours**

INTELLECTUAL PROPERTY

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property.

UNIT V **9 Hours**

INTELLECTUAL PATENT RIGHTS

Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. Procedure for grants of patents, Patenting under PCT. New Developments in IPR: Administration of Patent System. New developments in IPR, IPR of Biological Systems and Computer Software.

Total: 45 Hours

FOR FURTHER READING

Applying for patent and getting rights

References

1. Kothari, C.R., Research Methodology -Methods and techniques, New Age Publications, New Delhi, 2009.
2. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.
3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta Academic Publication, 5th edition, 2017.
4. Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners, SAGE Publications Ltd., 4th edition, 2014.
5. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, 2015.

OPEN ELECTIVES

18GE01 BUSINESS ANALYTICS 3 0 0 3

Course Objectives

- Understand the role of business analytics within an organization
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyze business data
- Use decision-making tools/Operations research techniques and Manage business process using analytical and management tools

Course Outcomes (COs)

1. Implement the knowledge of data analytics
2. Apply the ability of think critically in making decisions based on data and deep analytics.
3. Analyze the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
4. Determine the ability to translate data into clear, actionable insights
5. Analyze the decision problems in business analytics

UNIT I **9 Hours**

BUSINESS ANALYTICS AND STATISTICAL TOOLS

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics-Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

UNIT II **9 Hours**

TRENDINESS AND REGRESSION ANALYSIS

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

UNIT III **9 Hours**

ORGANIZATION STRUCTURES OF BUSINESS ANALYTICS

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization

UNIT IV **9 Hours**

FORECATING TECHNIQUES

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models

UNIT V **9 Hours**

DECISION ANALYSIS

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making

FOR FURTHER READING

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

Total: 45 Hours

Reference(s)

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press
2. Business Analytics by James Evans, persons Education

18GE02 INDUSTRIAL SAFETY 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To infer the safety requirement for chemical industry.
- To classify the various safety measures adopted in construction industries.

Course Outcomes (COs)

1. Demonstrate the safety management system of an industry.
2. Implement the provisions if acts and rules in industries.
3. Explain and review the safety performance followed in various industries.
4. Compare the safety appraisal of various industries.
5. Formulate safety reports on construction industries.

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Investigation and Reporting - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Motor Vehicle Rules, Explosive Act 1983, Boiler Act.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in metal working machinery and wood working machines, principles, standards and codes - Principles of machine guarding - zero mechanical state (ZMS),types of guards, Personal protective equipment- Safety in handling industrial gases, storage and handling of gas cylinders- Safety in cold forming and hot working of metals- Power press, forging, safety in furnaces, Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, non-destructive testing, vibration, corrosion Plant maintenance and emergency planning, management of maintenance HAZOP study, ALOHA, SOFTWARE.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Causes of fatal accidents, Construction regulations, contractual clauses, permit to work, Quality assurance in construction- Education and training Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights, Occupational Safety and Health Administration (OSHA) requirement for working at heights- Working on fragile roofs, work permit systems- Construction machinery, inspection and testing of cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, keys to safe demolition, health hazards from demolition, fire and explosion hazard- Safety in confined spaces.

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

Total: 45 Hours

Reference(s)

1. R.B.Blake, Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. V.Subramanian, The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras.
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1.
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

18GE03 OPERATIONS RESEARCH 3 0 0 3

Course Objectives

- To apply the dynamic programming to solve problems of discreet and continuous variables.
- To apply the concept of non-linear programming.
- To carry out sensitivity analysis
- To model the real world problem and simulate it

Course Outcomes (COs)

1. Explain the dynamic programming for discreet and continuous variables.
2. Demonstrate concept of non-linear programming
3. Identify the sensitivity analysis.
4. Formulate the real world problem and simulate it.

UNIT I **9 Hours**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II **9 Hours**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III **9 Hours**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV **9 Hours**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming

UNIT V **9 Hours**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Total: 45 Hours

Reference(s)

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

18GE04 COST MANAGEMENT OF ENGINEERING PROJECTS

3 0 0 3

Course Objectives

- To apply the decision making in cost management.
- To implement the execution of project and its contracts.
- To analyze cost behavior and profit planning marginal costing
- To apply activity-based cost management
- To explain quantitative techniques for cost management

Course Outcomes (COs)

1. Explain the decision making in cost management.
2. Demonstrate concept of project and its contracts
3. Identify the cost behavior and profit planning marginal costing.
4. Formulate the quantitative techniques for cost management.

UNIT I **9 Hours**

COST CONCEPTS IN DECISION-MAKING

Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II **9 Hours**

PROJECT

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance.

Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT III **9 Hours**

COST BEHAVIOR AND PROFIT PLANNING MARGINAL COSTING

Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning,

UNIT IV **9 Hours**

TOTAL QUALITY MANAGEMENT AND THEORY OF CONSTRAINTS

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V **9 Hours**

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Total: 45 Hours

Reference(s)

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

18GE05 COMPOSITE MATERIALS 3 0 0 3

9 Hours

Course Objectives

- To explain the characteristics of composite materials.
- To implement the particle reinforcements.
- To analyze manufacturing of metal matrix composites
- To apply manufacturing of polymer matrix composites
- To explain strength design and stress concentration

Course Outcomes (COs)

1. Explain the characteristics of composite materials.
2. Demonstrate concept of particle reinforcements
3. Identify the manufacturing of polymer matrix composites.
4. Formulate the strength design and stress concentration.

UNIT I **9 Hours**

INTRODUCTION

Definition - Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance

UNIT II **9 Hours**

REINFORCEMENTS

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT III **9 Hours**

MANUFACTURING OF METAL MATRIX COMPOSITES

Solid State diffusion technique, Cladding - Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration - Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT IV **9 Hours**

MANUFACTURING OF POLYMER MATRIX COMPOSITES

Preparation of Moulding compounds and prepares - hand layup method - Autoclave method - Filament winding method – Compression moulding - Reaction injection moulding. Properties and applications

UNIT V **9 Hours**

STRENGTH

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Total: 45 Hours

Reference(s)

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials- K.K.Chawla
3. Composite Materials Science and Applications - Deborah D.L. Chung.
4. Composite Materials Design and Applications - Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

18GE06 WASTE TO ENERGY 3 0 0 3

Course Objectives

- To explain the characteristics of energy from waste.
- To implement the Biomass Pyrolysis.
- To analyze manufacturing of Biomass Gasification
- To apply manufacturing of Biomass Combustion
- To explain the properties and application of Biogas

Course Outcomes (COs)

1. Explain the characteristics of energy from waste.
2. Demonstrate concept of Biomass Pyrolysis
3. Identify the manufacturing of Biomass Combustion.
4. Formulate the properties and application of Biogas.

UNIT I **9 Hours**

INTRODUCTION TO ENERGY FROM WASTE

Classification of waste as fuel Agro based, Forest residue, Industrial waste - MSW Conversion devices Incinerators, gasifiers, digestors

UNIT II **9 Hours**

BIOMASS PYROLYSIS

Pyrolysis - Types, slow fast - Manufacture of charcoal - Methods – Yields and application - Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III **9 Hours**

BIOMASS GASIFICATION

Gasifiers Fixed bed system Downdraft and updraft gasifiers Fluidized bed gasifiers Design, construction and operation Gasifier burner arrangement for thermal heating Gasifier engine arrangement and electrical power Equilibrium and kinetic consideration in gasifier operation.

UNIT IV **9 Hours**

BIOMASS COMBUSTION

Biomass stoves Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V **9 Hours**

BIOGAS

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Total: 45 Hours

Reference(s)

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

AUDIT COURSES

18XE11 RESEARCH PAPER WRITING 2 0 0 -

Course Objectives

- Understand that how to improve your writing skills and level of readability.
- Learn about what to write in each section.
- Recognize the skills needed when writing a Title.
- Ensure the good quality of paper at very first-time submission.

UNIT I **5 Hours**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II **5 Hours**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III **5 Hours**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV **5 Hours**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT V **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

UNIT VI **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Total: 30 Hours

Reference(s)

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

18XE12 TRADITIONAL TECHNICAL KNOWLEDGE

2 0 0 -

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects.
- Enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Course Outcomes (COs)

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in student

UNIT I **10 Hours**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

UNIT II **10 Hours**

Order, Introduction of roots, Technical information about Sanskrit Literature.

UNIT III **10 Hours**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

Total: 30 Hours

Reference(s)

1. "Abhyaspustakama" - Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3. "India's Glorious Scientific Tradition", Suresh Soni, Ocean books (P) Ltd., New Delhi.

18XE13 VALUE EDUCATION 2 0 0 -

Course Objectives

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Programme Outcomes (POs)

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

Course Outcomes (COs)

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I **8 Hours**

Values and self-development- Social values and individual attitudes-Work ethics- Indian vision of humanism- Moral and non- moral valuation-Standards and principles-Value judgements

UNIT II **7 Hours**

Importance of cultivation of values- Sense of duty Devotion- Self-reliance- Confidence-Concentration-Truthfulness- Cleanliness-Honesty- Humanity- Power of faith- National Unity- Patriotism- Love for nature-Discipline

UNIT III **8 Hours**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking- Integrity and discipline-Punctuality- Love and Kindness- Avoid fault Thinking- Free from anger- Dignity of labour-Universal brotherhood and religious tolerance-True friendship-Happiness Vs suffering- love for truth-Aware of self-destructive habits-Association and Cooperation-Doing best for saving nature

UNIT IV **7 Hours**

Character and Competence -Holy books vs Blind faith, Self-management and Good health. Science of reincarnation, Equality, Nonviolence ,Humility, Role of Women. All religions and same message, Mind your Mind, Self-control. Honesty, Studying effectively.

Total: 30 Hours

Reference(s)

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

18XE21 STRESS MANAGEMENT BY YOGA 2 0 0 -

Course Objectives

- To achieve overall health of body and mind
- To overcome stress by practicing yoga

Programme Outcomes (POs)

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

Course Outcomes (COs)

1. Develop healthy mind in a healthy body thus improving social health also.
2. Improve Efficiency of the body by practicing breathing exercises and yoga.

UNIT I **10 Hours**

Definitions of Eight parts of yoga. (Ashtanga)

UNIT II **10 Hours**

Yam and Niyam Do`s and Dont's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III **10 Hours**

Asan and Pranayam i) Various yoga poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam

Total: 30 Hours

Reference(s)

1. Yogic Asanas for Group Training-Part-I Janardan Swami Yogabhyasi Mandal, Nagpur. Model Curriculum of Engineering & Technology PG Courses [Volume-I][47].
2. Rajayoga or conquering the Internal Nature by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

18XE22 DISASTER MANAGEMENT 2 0 0 -

Course Objectives

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Course Outcomes (COs)

1. Understanding the key concepts in disaster risk reduction and humanitarian response
2. Understand the strengths and weaknesses of disaster management approaches, planning and programming

UNIT I **5 Hours**

INTRODUCTION

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II **5 Hours**

REPERCUSSIONS OF DISASTERS AND HAZARDS

Economic Damage, Loss of Human And Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks of Disease And Epidemics, War And Conflicts.

UNIT III **5 Hours**

DISASTER PRONE AREAS IN INDIA

Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV **5 Hours**

DISASTER PREPAREDNESS AND MANAGEMENT

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V **5 Hours**

RISK ASSESSMENT

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

UNIT VI **5 Hours**

DISASTER MITIGATION

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Total: 30 Hours

Reference(s)

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies " , New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi
3. Goel S. L. , "Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.
4. Model Curriculum of Engineering & Technology PG Courses [Volume-I][42]

18XE23 PEDAGOGY STUDIES 2 0 0 -

Course Objectives

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers
- Identify critical evidence gaps to guide the development.

Course Outcomes (COs)

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? verall personality

UNIT I **8 Hours**

INTRODUCTION AND METHODOLOGY

Aims and rationale- Policy background- Conceptual framework and terminology-Theories of learning-Curriculum- Teacher education-Conceptual framework- Research questions-Overview of methodology and Searching

UNIT II **7 Hours**

THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education

UNIT III **8 Hours**

EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy?. Theory of change, Strength and nature of the body of evidence for effective pedagogical, practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies

UNIT IV **7 Hours**

PROFESSIONAL DEVELOPMENT

Alignment with classroom practices and follow up, Support Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Total: 30 Hours

Reference(s)

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, "learning to read" campaign.