M.E. (Industrial Automation and Robotics)

2021 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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BANNARI AMMAN INSTITUTE OF TECHNOLOGY
REGULATIONS 2021
(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) Students admitted under 'Full-Time' should be available in the departments during the entire duration of working hours (from morning to evening on a full-time basis) for the curricular, co-curricular and extra-curricular activities.

The full-time students should not attend any other full-time programme(s) / course(s) or take up any full-time job / part-time job during working hours in any institution or company during the period of the full-time programme. Violation of the above rules will result in the cancellation of admission to the PG programme.

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 will be divided into four 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, these periods being reckoned from the commencement of the first semester to which the candidate was first admitted, regardless of the break-of-study availed.

3. BRANCHES OF STUDY

Following M.E./M.Tech. programmes are offered by the institute

M.E. Programmes

1. Communication Systems
2. Computer Science and Engineering

3. Embedded Systems
4. Industrial Automation and Robotics
5. Industrial Safety Engineering
6. Power Electronics and Drives
7. Software Engineering
8. Structural Engineering

M. Tech. Programme

9. 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

Program Core Courses (PCC) include the core courses relevant to the chosen specialisation.

Program Elective Courses (PEC) include the elective courses relevant to the chosen specialisation.

Research Methodology and IPR Course to understand the importance and the process of creation of patents through research.

Employability Enhancement Courses (EEC) include project work, practical courses, internship, mini project and industrial/practical training.

Audit Courses (AC) expose the students to Disaster Management, Yoga, English for Research Paper Writing, Value education, Pedagogy Studies, Stress Management, and Personality Development through Life Enlightenment Skills. Registration for any of these courses is optional to students.

(ii) **Project Work:** Every student, individually, shall undertake Dissertation Phase I during the third semester and Dissertation Phase II during the fourth semester under the supervision of a qualified faculty. The project work can be undertaken in an industrial / research organisation or institute in consultation with the faculty guide and the Head of the Department. In the case of project work at an industrial / research organisation, the same shall be jointly supervised by a faculty guide and an expert from the organisation. The student shall be instructed to meet the supervisor periodically and attend the review committee meetings to evaluate the progress.

(iii) **Elective Courses: Five Elective** courses are offered to the students admitted in various disciplines as prescribed in the curriculum to widen their knowledge in their specialisation 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 six credits. Such students may be exempted

from attending the classes if such course(s) are offered in the semester. Summary of such online 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 Examinations. 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 Controller of Examinations.

(v) **Industrial Training:** Every full-time student shall take up training in industry/research laboratories, under the supervision of a faculty guide during summer/winter vacation till the pre-final semester of the programme subject to the evaluation prescribed in Clause 15.

If industrial training/internship is not prescribed in the curriculum, the student may undergo industrial training/internship optionally, and the credits earned will be indicated in the Mark Sheet. If the student earns three credits in industrial training/internship, the student may drop one Program Elective in the III semester. In such cases, industrial training/internships need to be undergone continuously from one organisation only. However, if the number of credits earned is 1 or 2, these credits shall not be considered for the classification of the degree. The student is only allowed to undergo a maximum of 6 weeks of industrial training/internship during the entire duration of the study.

Duration of Training / Internship	**Credits**
2 Weeks	1
4 Weeks	2
6 Weeks	3

(vi) **Mini Project**: The students shall undertake a mini project 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 Clause 15.

(vii) **Value Added / Certificate Courses:** Students can opt for any one of the value-added courses in II and III semesters, 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 hour of tutorial per week. The exact numbers of credits assigned to the different courses of various programmes are decided by the respective Board 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. Communication Systems	68
2.	M.E. Computer Science and Engineering	68
3.	M.E. Embedded Systems	68
4.	M.E. Industrial Automation and Robotics	68
5.	M.E. Industrial Safety Engineering	68
6.	M.E. Power Electronics and Drives	68
7.	M.E. Software Engineering	68
8.	M.E. Structural Engineering	68
9.	M.Tech. Biotechnology	68

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 enrol 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 semester II will commence 10 working days prior to the last working day of the semester I. The student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of 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 authorised by the PG coordinator of the programme. In this case, if a student fails in a course, he/she may be permitted to register for 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-enrol 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. Dissertation phase I is to be undertaken during the III semester, and dissertation phase II, which is a continuation of phase I, is to be undertaken during the IV semester. Minimum 24 credits are required to be earned to enrol on dissertation phase I.

If a student fails to earn the requisite minimum credits, the student cannot enrol for dissertation phase I. In such a case, the student can enrol 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 to register for additional courses or drop existing courses. The total number of credits that a student can add or drop is limited to 6, subject to a maximum of 2 courses. In such cases, the attendance requirement as stated in Clause 6 is mandatory.

The courses that a student registers in a particular semester may include:

i. Courses of the current semester and

ii. Courses dropped in the lower semesters.

The maximum number of credits that can be registered in a semester is 36. However, this does not include the number of Re-appearance (RA) and Withdrawal (W) courses registered by the student for the appearance of Examination.

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/mini project 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 the 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 the full-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 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 hospitalisation/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 permission to attend the examinations.

6.3 A student shall normally be permitted to appear for the end semester examination of a course if the student has satisfied the attendance requirements (vide Clause 6.1-6.2) and has registered for the examination in those courses of that semester by paying the prescribed fee.

6.4 A student who does not satisfy clauses 6.1 and 6.2 and secures less than 70% attendance in a course will not be permitted to write the end semester examination. 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 to improve grades/marks.

7. FACULTY ADVISOR

To help students plan their courses of study and for general advice on the academic programme, the Head of the Department of the students will attach a certain number of students to a teacher of the department, who shall function as a faculty advisor for those students throughout their period of study. The faculty advisor shall advise the students in registration and reappearance (Arrear) registration of courses, authorise the process, 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.

The responsibilities of the faculty advisor shall be:

i. To inform the students about the various facilities and activities available to enhance the student's curricular and co-curricular activities.

ii. To guide student enrolment and registration of the courses

iii. To authorise the final registration of the courses at the beginning of each semester.

iv. To monitor the academic and general performance of the students, including attendance, and to counsel them accordingly.

v. To collect and maintain the academic and co-curricular records of the students

8. COMMITTEES

8.1 Class Committee Meeting

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

ii. One of the faculty members (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 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, to report 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 timetable circulated by the CoE's Office. 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 needs 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 experts consisting of an internal examiner, usually the supervisor, and an external examiner, appointed by the Controller of the Examination.

A candidate is permitted to register for dissertation phase II only after passing 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 the percentage of total marks secured by a candidate in an individual course as detailed below:

Letter Grade	**Grade Points**
O (Outstanding)	10
A + (Excellent)	9
A (Very Good)	8
B + (Good)	7
B (Above average)	6
C (Satisfactory)	5
RA (Reappearance Registration)	0
I (Incomplete)	0
W (Withdrawal)	0
AB (Absent)	0
SA(Shortage of Attendance)	0

'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 he/she secures a minimum of 50% of the total mark in the end semester examination of that course.

If a student fails to secure a pass in theory courses and laboratory courses in the current semester examination, he/she is allowed to write arrear examinations for the next three consecutive semesters, and their internal marks shall be carried over for the above mentioned period of three consecutive semesters.

In case if he/she has not completed all the courses of the semester I at the end of semester IV, he/she shall redo the semester I courses along with regular students. The same procedure shall be followed for the subsequent semesters of II, III and IV, subject to the maximum permissible period for this programme.

9.7 If a candidate fails in the end semester examinations of Phase I, he/she has to resubmit the project report within 30 days from the date of declaration of the results. If he/she fails in the end semester examination of Phase II of M.E. / M.Tech., he/she shall resubmit the project report within 60 days from the date of declaration of the results. The resubmission of the project report and the subsequent viva voce examination will be considered as reappearance with payment of the exam fee. If a student fails to resubmit the project report within the stipulated period and fails in the subsequent viva-voce examination, the student shall register for the course again in the subsequent semester.

10. REJOINING THE PROGRAMME

A candidate who has not completed the study of any of the semesters 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 a case, earlier continuous assessment in the repeated courses will be disregarded. However, no candidate will be allowed to enrol 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 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 THE DEGREE AWARDED

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:

- Should have passed the examination in all the courses of all the four semesters in the student's First Appearance within two years (Three years in case of authorised break of study of one year (if availed)). 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:

- Should have passed the examination in all the courses of all four semesters within three years, including one year of authorised 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 (not covered in clauses 12.1 and 12.2) who qualify for the award of the degree shall be declared to have passed the examination in the second class.

12.4 A student who is absent in the End Semester Examination in a course/project work after having registered for the same shall be considered to have appeared in that examination (except approved withdrawal from end semester examinations as per clause 13) for the purpose of classification.

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) 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 withdrawal request 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 If a student withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examination(s)

13.4 Withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for first class with distinction or first class.

13.5 Withdrawal is permitted for the end semester examinations in the final semester only if the period of study the student concerned does not exceed 3 years for M.E. / M.Tech. as per clauses 12.1 and 12.2.

14. AUTHORISED BREAK OF STUDY FROM A PROGRAMME

14.1 A student is permitted to go on a break of study for a fixed period of one year as a single break in the entire course of study.

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 the 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 re-join the programme after a break of study/prevention

due to lack of attendance shall be governed by the curriculum and regulations in force at the time of re-joining. A committee constituted by the Head of the Institution shall prescribe additional/equivalent courses, if any, from the regulation in force to bridge the requirement between the 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 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 authorised 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 (15)	
	Periodical Test II (15)	
	Term Paper Report (10) & Presentation (10)	
	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)	
	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:	
	Review I	
	Identification of topic and Justification (5)	
	Literature Survey (5)	
	Review II	
	Work plan & Approach (10)	
	Progress, Results and Discussion (10)	
	Review III	
	Conclusion (10)	
	Implementation & Applications (10)	

	End Semester Examination	
	Presentation (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

V	**DISSERTATION PHASE II**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Review I	
	Work plan & Approach (10)	
	Review II	
	Progress (10)	
	Results and Discussion (10)	
	Review II	
	Conclusion (10)	
	Implementation & Applications *(10)*	
	End Semester Examination	
	Presentation (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**
	Presentation & Viva voce	**50**
	Total Marks	**100**

VII	**INDUSTRIAL TRAINING / INTERNSHIP**	**Marks**
	Continuous Assessment	**100**
	Presentation	**30**
	Viva-voce	**30**
	Case study / Report	**40**
	Total Marks	**100**

VIII	**VALUE ADDED COURSES / CERTIFICATE COURSES (Continuous Assessment Only)**	**Marks**
	Test I	50
	Test II	50
	Grades: Excellent (>80) / Good (61≤Marks ≤ 80) / Satisfactory (50≤Marks ≤ 60))	

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 (hospitalisation / 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.

M.E. – INDUSTRIAL AUTOMATION AND ROBOTICS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates will be able to

I. Demonstrate 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. Meet societal needs through innovations, leadership quality, inter-personal skills and have strong commitment to pursue life-long learning.

PROGRAMME OUTCOMES (POs)

Students will be able to

PO1: Carry out research/investigation and to independently solve problems related to the field of automation & robotics.

PO2: Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.

PO3: Write and present a substantial technical report/document.

PO4: Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability.

PO5: Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

PO6: Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments.

MAPPING OF PEOs AND POs

PEO(s)	PROGRAMME OUTCOME(s)					
	(PO1)	(PO2)	(PO3)	(PO4)	(PO5)	(PO6)
I	X	X		X		X
II	X		X		X	X
III	X	X	X	X	X	

Minimum credits to be earned: 68

First Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21IR11	Researchmethodology and IPR	I,II,III	a,c,e,f	2	0	0	2	3
21IR12	Automation in manufacturing	I,II,III	a,b,d,e,f	3	0	0	3	3
21IR13	Industrial robotics	I,II,III	a,b,d,e	3	0	0	3	3
21IR14	Sensors applications in Manufacturing	I,II,III	a,b,d,e,f	3	0	0	3	3
	Program elective I			3	0	0	3	3
21IR16	Sensors &signal Conditioning laboratory	I,II	a,b,c,d,e	0	0	4	2	4
21IR17	Industrial robotics laboratory	I,II	a,b,c,d,e	0	0	4	2	4
	Audit course I*			2	0	0	-	2
			Total				**18**	
Second Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21IR21	Design of mechanisms and manipulators	I,II,III	a,b,d,e,f	3	1	0	4	4
21IR22	Industrial automation And control	I,II,III	a,b,d,f	3	0	0	3	3
21IR23	Machine vision system	I,II,III	a,b,c,e,f	3	0	0	3	3
	Program Elective II			3	0	0	3	3
	Program Elective III			3	0	0	3	3
21IR26	Automation laboratory	I,II	a,b,c,d,e	0	0	4	2	4
21IR27	Mini project	I,II,III	a,b,c,d,e,f	0	0	4	2	4
	Audit course II*			2	0	0	-	2
			Total				**20**	
Third Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
	Program Elective IV			3	0	0	3	3
	Program Elective V			3	0	0	3	3
21IR33	Dissertation Phase I	I,II,III	a,b,c,d,e,f	0	0	20	10	20
			Total				**16**	

Fourth Semester								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21IR41	Dissertation Phase II	I,II,III	a,b,c,d,e,f	0	0	28	14	28

List of Core Electives								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21IR51	Design of fluid power systems	I,II,III	a,b,d,e,f	3	0	0	3	3
21IR52	Industrial drives and control	II,III	a,b,d,f	3	0	0	3	3
21IR53	Modern manufacturing system	I,II,III	a,b,c,d,e	3	0	0	3	3
21IR54	Embedded systems	I,II,III	a,b,e,f	3	0	0	3	3
21IR55	Field and service robots	I,II	a,b,d,f	3	0	0	3	3
21IR56	Modern material handling systems	I,II,III	a,b,d,e,f	3	0	0	3	3
21IR57	Artificial intelligence	I,II	a,b,d,e,f	3	0	0	3	3
21IR58	Industrial data networks	I,II	a,b,e,f	3	0	0	3	3
21IR59	Process consulting and project planning	II,III	a,b,d,e,f	3	0	0	3	3
21IR60	Robot economics	I,III	a,b,d,f	3	0	0	3	3
21IR61	Control system	I,II	a,b,d,f	3	0	0	3	3
21IR62	Virtual Instrumentation	II,III	a,b,d,f	3	0	0	3	3
21IR63	Electrical vehicle systems	II,III	a,b,e,f	3	0	0	3	3

List of Audit courses I & II								
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**	**Hours/ Week**
		PEOs	**POs**					
21XE01	English for Research Paper Writing	I,II,III	c,f	2	0	0	-	2
21XE02	Cost Management of Engineering Projects	I,II,III	c,d,f	2	0	0	-	2
21XE03	Stress Management	I,II,III	d,e	2	0	0	-	2
21XE04	Disaster Management	I,II,III	e,f	2	0	0	-	2
21XE05	Value Education	I,II,III	d,e	2	0	0	-	2
21XE06	Pedagogy Studies	I,II,III	c,f	2	0	0	-	2
21XE07	Business Analytics	I,II,III	c,d,e	2	0	0	-	2

21IR11 RESEARCH METHODOLOGY AND IPR 2 0 0 2

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
c. Write and present a substantial technical report/document
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Formulate the research problem using specific methods
2. Implement the research related information and follow research ethics
3. Compare the Hypotheses Testing process and its methods
4. Integrate the important role in growth of individuals & nation
5. Determine the significance of patent rights and patent administration systems

UNIT I **6 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 **6 Hours**

LITERATURE STUDIES AND TECHNICAL WRITING

Effective literature studies approaches, analysis Plagiarism, 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 **6 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 **6 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 **6 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

FOR FURTHER READING

Applying for patent and getting rights

Total: 30 Hours

Reference(s)

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, 2nd 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.

21IR12 AUTOMATION IN MANUFACTURING 3 0 0 3

Course Objectives

- To review the fundamentals of design of automated system.
- To select the electrical components based on the specific requirements
- To apply an appropriate mechanism to design automated circuits for suitable applications.

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Design of automated systems using various components
2. Select suitable drives and mechanism for an automated manufacturing system
3. Apply suitable material handling and identification technique in automated manufacturing
4. Construct the automation system with different types of assembly lines
5. Analyze the concepts of part feeding and flexible manufacturing system.

UNIT I **9 Hours**

INTRODUCTION TO AUTOMATED SYSTEM

Importance of automation in the manufacturing industry - Basic concepts - Mechatronics based systems - automated systems and equipment used in manufacturing part - Building blocks of an automated system, working principle and examples - Manufacturing operations, production facilities.

UNIT II **9 Hours**

DRIVES AND MECHANISMS OF AN AUTOMATED SYSTEM

Drives: stepper motors, servo drives. Mechanism: Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

UNIT III **9 Hours**

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES

Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

UNIT IV **9 Hours**

MANUFACTURING AND AUTOMATED ASSEMBLY SYSTEMS

Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

UNIT V **9 Hours**

PART FEEDING

Reciprocating Tube Hopper Feeder: Principle of Operation; External Gate Hopper Feeder: Its Analysis: Maximum Peripheral Velocity, Mean Feed rate; Rotary Disk Feeder: Indexing and Rotary Disk Feeder with continuous drive and their analysis: Load sensitivity, Efficiency and Mean Feed Rate; Orientation of Parts in Automatic Assembly: In-Bowl and Out-of-Bowl Toolings. Flexible Manufacturing Systems: What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues.

FOR FURTHER READING

Automated inspection, Manufacturing support systems, Shop floor control, Just in time and lean production

Total: 45 Hours

Reference(s)

1. Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall, 2001
2. Automation, production systems and computer integrated manufacturing/ Mikell. P Groover/PHI/3rd edition, 2012.
3. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers, 2003.
4. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
5. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson, 2009.
6. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers

21IR13 INDUSTRIAL ROBOTICS 3 0 0 3

Course Objectives

- To enlighten the fundamentals of robotic systems
- To familiarize the fundamentals of sensors and its application
- To impart the knowledge about various drive systems and its selection for particular applications.
- To execute the knowledge about kinematic and dynamic analysis of robot manipulators

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

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. Analyse robot kinematics and trajectory planning
5. Compare scaling effect and design micro actuators

UNIT I **9 Hours**

INTRODUCTION TO ROBOTICS

Robot Anatomy-Definition, three laws, Degrees of Freedom, Elements of Robotic Systems, 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. Collaborative Robot and its applications

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. Robot Safety-Safety Monitoring devices in 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

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. Deb .S.R, Robotics Technology and flexible automation Tata McGraw-Hill Education, 2017, 2nd Edition
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 Edition-2nd, 2011, Reprint-2014

21IR14 SENSORS APPLICATIONS IN MANUFACTURING

3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Select the system using various Sensors and signal conditioning unit
2. Construct the system using appropriate sensors for different industrial applications.
3. Implement Non-contact sensors for manufacturing, defense, distribution, retail and health care sectors.
4. Apply the Sensors in Flexible Manufacturing System
5. Analyze the sensors used in Manufacturing applications.

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.

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.

Total: 45 Hours

Reference(s)

1. SabrieSoloman, 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.
5. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf

21IR16 SENSORS AND SIGNAL CONDITIONING LABORATORY

0 0 4 2

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
c. Write and present a substantial technical report/document
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

Course Outcomes (COs)

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

1 **4 Hours**

EXPERIMENT 1

Interface a thermocouple to monitor the temperature in a thermal chamber and controlling a fan with the help of an IoT module and heating source to maintain the temperature of the chamber within a specified tolerance limit.

2 **4 Hours**

EXPERIMENT 2

Interface a RTD to monitor the temperature of the cooking oven in the food processing industry and controlling the temperature within the limits with the help of an IoT module.

3 **4 Hours**

EXPERIMENT 3

Measurement of damping ratio of a machine tool base from free vibration studies using an accelerometer pick up with data acquisition system.

4 **4 Hours**

EXPERIMENT 4

Interfacing of strain gauge set up to measure strains in a statically loaded machine structure and calibration of the same.

5 **4 Hours**

EXPERIMENT 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.

6 **4 Hours**

EXPERIMENT 6

Interface the load cell with data acquisition system to measure the applied load and to display the data.

7 **4 Hours**

EXPERIMENT 7

Interface the servo motor with PC for speed and position control of robot

8 **4 Hours**

EXPERIMENT 8

Interface ADC with PC for converting analog recording data into digital signal which is stored in CD.

9 **4 Hours**

EXPERIMENT 9

Interface DAC with PC to convert digital video data into analog video signals which connect to the screen drivers to display color images

10 **4 Hours**

EXPERIMENT 10

Analyze the frequency spectrum of microphone by interfacing with DAQ for measuring the audio signal

11 **4 Hours**

EXPERIMENT 11

Design a controller for two wheel self-balancing robots for variable loads.

12 **4 Hours**

EXPERIMENT 12

Design a controller for controlling the ball on beam in the desired position

13 **4 Hours**

EXPERIMENT 13

Measurement of damping ratio of a machine tool base from free vibration studies using an accelerometer pick up with data acquisition system

14 **4 Hours**

EXPERIMENT 14

Develop a LabVIEW program for monitoring of furnace temperature using Data Aquisition System

15 **4 Hours**

EXPERIMENT 15

Develop a LabVIEW program to control LED display output using Data Aquisition System

Total: 60 Hours

Reference(s)

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI Learning Pvt. Ltd, New Delhi, 2010.
2. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.
3. LabVIEW: Basics I & II Manual, National Instruments, Bangalore, 2011.

21IR17 INDUSTRIAL ROBOTICS LABORATORY 0 0 4 2

Course Objectives

- To analyze the different types of robots and their configurations.
- To create programming for the SCARA robot

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
c. Write and present a substantial technical report/document
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

Course Outcomes (COs)

1. Modeling and analysis of different types of robots and their configurations using RoboAnalyzer software.
2. Modeling a SCARA Robot using an industrial robot simulation system
3. Generate a motion planning module for the SCARA and articulated robot

1 **4 Hours**

EXPERIMENT 1

Modeling and analysis of different types of robots and their configurations using RoboAnalyzer software

2 **4 Hours**

EXPERIMENT 2

Modeling a SCARA Robot using an industrial robot simulation system

3 **4 Hours**

EXPERIMENT 3

Modeling an Articulated robot using an industrial robot simulation system

4 **4 Hours**

EXPERIMENT 4

Carryout the forward and inverse kinematics of SCARA robot and calculate the joint notations using simulation software

5 **4 Hours**

EXPERIMENT 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

6 **4 Hours**

EXPERIMENT 6

Generate a program for forward kinematics numerical solution for 5 degrees of freedom robot manipulator

7 **4 Hours**

EXPERIMENT 7

Program a 6 axis articulated robot for performing pick and place operation using software and teach pendant.

8 **4 Hours**

EXPERIMENT 8

Program a 6 axis articulated robot for drilling application using software and teach pendant.

9 **4 Hours**

EXPERIMENT 9

Develop a point to point motion program using 6 axis industrial robot for pick and place operation

10 **4 Hours**

EXPERIMENT 10

Program a 6 axis articulated robot for repeated loading and unloading operation using software and teach pendant.

11 **4 Hours**

EXPERIMENT 11

Create a program in CpROG environment for pick and place operation.

12 **4 Hours**

EXPERIMENT 12

carry out forward kinematics of PRP configured robot and calculate the joint notations using simulation software

13 **4 Hours**

EXPERIMENT 13

Develop a continuous motion program using 6 axis industrial robot for spray painting

14 **4 Hours**

EXPERIMENT 14

carry out forward kinematics of 3R robot and calculate the joint notations using simulation software

15 **4 Hours**

EXPERIMENT 15

carry out forward kinematics of 3P robot and calculate the joint notations using simulation software

Total: 60 Hours

Reference(s)

1. 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, 2017
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision, and Intelligence, Tata McGraw-Hill Publishing Company Limited, India, 2017
3. AshitavaGhosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2008.

21IR21 DESIGN OF MECHANISMS AND MANIPULATORS

3 1 0 4

Course Objectives

- To design the mechanism for the robot manipulator by applying suitable techniques.
- To analyze the velocity and dynamics of the robot manipulator.
- To select the appropriate robot for the given application.

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Characterize the parameters involved in the design and mobility of manipulators and mechanisms.
2. Design and optimize the mechanism for the manipulator to have dexterous structural rigidity.
3. Analyse the manipulator kinematics for different configurations of robot.
4. Apply various methods for developing the dynamics equations for robot manipulators.
5. Select the appropriate robot manipulator for a particular application to carry out a desired task

UNIT I **9 Hours**

MECHANISM FOR MANIPULATORS

Mobility analysis - Degrees of Freedom (DOF) - Mixed Mobility - Total Partial and Fractional DOF (Simple problems)-Closed and Open Chain Systems - Manipulators - Classifications- Workspace based classification, Nature of motion based classification - actuation and transmission systems - Harmonic drives, Gear drives and belt drives.

UNIT II **9 Hours**

DESIGN OF ROBOT MECHANISM

Quantitative Measures of workspace attributes - Length Sum of a manipulator, Structural Length Index (SLI) - SCARA, 2 DOF Planar Robot arm SLI calculation, Inertia Ellipsoid- Stiffness and Deflections - Cholesky decomposition- Unmodeled Flexibility and its effect - Equivalent mass and inertia - Structural frequency Analysis and Synthesis of mechanisms - Introduction to Geometric Constraint Programming.

UNIT III **9 Hours**

MANIPULATOR KINEMATICS

Homogeneous Coordinate transformation - Denavit Hartenberg Arm matrix of SCARA - Alpha-II, PUMA articulated robot, polar frame, Eigenvectors-Canonical basis - QR Factorization-.inverse and forward kinematics of SCARA, Articulated PUMA arm (simple problems) - Least squares method-Singular value decomposition Jacobian - Manipulability analysis - Workspace Singularities, Degeneracy, Dexterity - Inverse velocity and acceleration.

UNIT IV **9 Hours**

MANIPULATOR DYNAMICS

Effective Moment of Inertia - Lagrangian Mechanics - Lagrangian formulation of manipulator dynamics - Newtons and Eulers equation of Manipulator dynamics - Dynamic equations of 2DOF and 3 DOF planar robot arm using Lagrangian and Newtonian Mechanics - Torque calculations - Closed form dynamic equations - Static force Analysis of Robots - Transformation of Forces and Moments between Coordinate Frames.

UNIT V **9 Hours**

MANIPULATOR SELECTION

Selection of robots for different robot applications - Applications of Articulated robots in Welding, Painting, Machine tending, Assembly and Inspection - Reliability of robotic and automation systems and their evaluation.

FOR FURTHER READING

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

Total: 45+15=60 Hours

Reference(s)

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,2nd Edition, 2020.
4. AppuKuttan, Robotics, I.K. International Publishing house, New Delhi, 2007.
5. Saeed B Niku, Introduction to Robotics: Analysis, Control, Applications, 2nd Edition, 2010, Wiley Publications
6. Venkataraman Subramanian T. and Iberall Thea (Eds.), Dextrous Robot Hands, Springer Publications.

21IR22 INDUSTRIAL AUTOMATION AND CONTROL 3 0 0 3

Course Objectives

- To understand the need of automation in various industrial sectors
- To learn about the various technology developments such as PLC, SCADA and DCS in industrial automation.
- To understand the basics of communication with its protocol

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Outline the different automation functions and its need in automation industries.
2. Apply the different instructions available in PLC for various applications
3. Create process control applications virtually on supervisory control and data acquisition systems
4. Integrate the distributed control system and differentiate the DCS over other automation systems
5. Use 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 - Collaborative process industry - safety

UNIT II **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Evolution of PLC-Architecture-Processor Memory Organization: Program Files, Data Files-PLC Programming Languages- PLC I/Os - Sourcing and Sinking - 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 andUser 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-Devicenet - CAN network - Ethercat - System Operation and Troubleshooting.

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

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, 2016
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.

21IR23 MACHINE VISION SYSTEM 3 0 0 3

Course Objectives

- To learn the fundamentals of vision systems
- To understand the image recognition and retrieval algorithms
- To learn the concepts of object recognition and applications of vision systems

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
c. Write and present a substantial technical report/document
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Plan a setup required for performing the given machine vision application
2. Apply the required processing techniques for enhancing the image to identify objects
3. Analyze images for object recognition from the enhanced image
4. Apply machine vision concept for inspection in manufacturing industries
5. Interface 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 segmentationSegmentation 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 Patterns, Recognition Based on Decision-Theoretic Method: Matching, Optimum Statistical Classifiers, Neural Network, Structural method: Matching shape numbers, String Matching

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. Vision Guided Robots

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. Alexander Hornberg, Handbook of Machine and Computer Vision WILEY-VCH, 2017.
2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, 3rd edition, 2008.
3. Carsten Steger, Markus Ulrich, Christian Wiedemann, Machine Vision Algorithms and Applications, WILEY-VCH, Weinheim, 2008
4. Damian M Lyons, Cluster Computing for Robotics and Computer Vision, World Scientific, Singapore, 2011
5. Shimon Ullman, High-Level Vision: Object recognition and Visual Cognition, A Bradford Book, USA, 2000.
6. R.Patrick Goebel, ROS by Example: A Do-It-Yourself Guide to Robot Operating System Volume, A Pi Robot Production, 2012.

21IR26 AUTOMATION LABORATORY 0 0 4 2

Course Objectives

- To impart skills and knowledge in automation using hardware and software components for industrial applications.
- To enhance the knowledge in electro-mechanical concepts and programming of electronic controllers for automation applications.

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
c. Write and present a substantial technical report/document
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

Course Outcomes (COs)

1. Interface sensors and actuators with microcontroller.
2. Design an automation system using electrical drives and controllers
3. Develop the PLC program to control actuators
4. Measure and inspect the components using machine vision system

1 **4 Hours**

EXPERIMENT 1

Convert the Media Access Control address into decimal system to identify the manufacture and network interface controller using 8051 microcontroller.

2 **4 Hours**

EXPERIMENT 2

Interface 7 segment display with PIC microcontroller

3 **4 Hours**

EXPERIMENT 3

Interface 16x2 display and 128x32 display with Arduino microcontroller to provide the visual alert to the machine operator

4 **4 Hours**

EXPERIMENT 4

Interface the temperature sensor and relay actuator using Arduino microcontroller to control the temperature

5 **4 Hours**

EXPERIMENT 5

Implement the drive startup with keypad and motion studio software for open loop drive system

6 **4 Hours**

EXPERIMENT 6

Develop the parameter configuration for operation of drive in open loop system

7 **4 Hours**

EXPERIMENT 7

Implement the drive startup with keypad and motion studio software for closed loop drive system

8 **4 Hours**

EXPERIMENT 8

Automate the cylinder sequencing process using PLC program

9 **4 Hours**

EXPERIMENT 9

Automate the cylinder sequencing process using PLC

10 **4 Hours**

EXPERIMENT 10

Control the level and flow of fluid using PLC program

11 **4 Hours**

EXPERIMENT 11

Control of automatic bottle filling process using PLC program

12 **4 Hours**

EXPERIMENT 12

Design a PLC program to control the traffic light system

13 **4 Hours**

EXPERIMENT 13

Interface variable frequency drive using PLC program

14 **4 Hours**

EXPERIMENT 14

Design a SCADA screen for automatic fluid level monitoring system

15 **4 Hours**

EXPERIMENT 15

Control the pressure and flow of fluid using DCS

Total: 60 Hours

Reference(s)

1. Krishna Kant, Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096, PHI, 2013
2. A. K. Sawhney and P. Sawhney, A Course on Mechanical Measurement Instrumentation and Control, Dhanpat Rai and Co, New Delhi, 2017.
3. Antony Esposito, Fluid Power Systems and Control, Prentice-Hall, 2006.
4. Peter Rohner, Fluid Power Logic Circuit Design, The Macmillan Press Ltd., London, 2009

21IR51 DESIGN OF FLUID POWER SYSTEMS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

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

UNIT I **9 Hours**

INTRODUCTION

Fluid power system-Applications of Pascals law-Components of Hydraulic and Pneumatic systems-Advantages-Drawbacks-Applications-Fluid Power symbols-Toricellis theorem-Darcys 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 - Installation - Fault diagnosis in fluid power circuits

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

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
6. https://nptel.ac.in/courses/112/106/112106175/#

21IR52 INDUSTRIAL DRIVES AND CONTROL 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

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. Determine the 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

Introduction to 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

Definition and Basics of vector-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- Compare Synchronous motor with Asynchronous motor

UNIT V **9 Hours**

INDUSTRIAL DRIVES AND CONTROL

Laplace Transform - Sufficient conditions -P, PI and PID controller characteristics - simulation of converter and chopper fed dc drive - Transforms of elementary functions - Basic Properties - Transforms of derivatives and integrals - Phase locked loop and microcomputer control of dc drives - selection of drives and Control of drives for textile mills, lifts, cranes and hoist drives

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

Total: 45 Hours

Reference(s)

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2020.
2. VedamSubramanyam, 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, 1981.
6. Gopal K. Dubey, Fundamentals of Electrical Drives, New Delhi, 2nd Edition, Narosa Publishing House, 2009.

21IR53 MODERN MANUFACTURING SYSTEM 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
c. Write and present a substantial technical report/document
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

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 center
4. Exemplify the generic steps and classification of Rapid Manufacturing
5. Compare the manufacturing process of rapid prototype methods 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-Recirculating ball screws linear motion guide ways-Tool magazines and ATC-Applications of Lathe and Vertical Milling

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 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 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

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. YoramKoren, Computer Control of Manufacturing Systems, Tata McGraw-Hill Publishing Company, 2009
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. 6. C K Chuak, F Leongc and S Lim, Rapid Prototyping, Yes Dee Publishing, 2010

21IR54 EMBEDDED SYSTEMS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments.

Course Outcomes (COs)

1. Elucidate the concepts of an embedded system and compare with general purpose System
2. Compare the various embedded processor and internal memory architecture
3. Analyze the various Input and output devices and Network protocols
4. Investigate the concepts of RTOS and related mechanisms to apply them to develop embedded product
5. Evaluate the design methodologies for the real time application and get introduced to Raspberry Pi

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,LoRa]

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] - Introduction to ROS

UNIT V **9 Hours**

EMBEDDED SYSTEM DEVELOPMENT AND INTRODUCTION TO RASPBERRY PI

Design Methodologies [UML as Design tool, UML notation, Requirement Analysis and Use caseModeling] - Design Examples [Telephone PBX, Inkjet Printer, PDA, Elevator Control System, ATM System] - Fault-tolerance Techniques - Reliability Evaluation Techniques.Working with Raspberry Pi 3 Model - Installing OS and Designing Systems using Raspberry pi - Configuring Raspberry Pi for VNC Connection - Getting introduced to Linux OS- Basic Linux commands and uses

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

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 PSoCNewnes, 2015
5. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. MCKinlay The 8051 Microcontroller and Embedded Systems,2nd Edition, Pearson Education 2008

21IR55 FIELD AMD SERVICE ROBOTS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments.

Course Outcomes (COs)

1. Summaries the history, needs and types of robots in various sectors
2. Apply the localization and mapping of mobile robot in any dynamic environment
3. Analyze the shortest path for mobile robots
4. Apply mobile robot for various applications such as agriculture, military and home.
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. Introduction to Robot operating system

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, Mobile Robot for Home application.

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.

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. Roland Siegward, Illah Reza Nourbaksh and Davide Scaramuzza, Introduction to Autonomous Mobile Robots, Bradford Company Scituate, USA 2010.
2. RaidhSiaer, 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

21IR56 MODERN MATERIAL HANDLING SYSTEMS 3 0 0 3

Course Objectives

- To understand the latest material handling system used in industries
- To explore the concept of Automated Guided Vehicle System

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Recognise 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 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 &placeoperations machine loading & unloading characteristics of robot application, case studies

FOR FURTHER READING

Methods of protecting materials for packages - auxiliary equipments - automated identifications systems using AI & IOT

Total: 45 Hours

Reference(s)

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 PLtd, 1996
4. Ray Asfahl, Robots and Manufacturing Automation, Wiley India, 2012
5. Charles D Reese, Material Handling Systems, Taylor And Francis, 2000

21IR57 ARTIFICIAL INTELLIGENCE 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Analyze the concepts of connectives using the logic of artificial intelligence
2. Apply the various search and matching techniques for problem solving
3. Apply the methods of optimization for knowledge organization and representation of structures
4. Analyze the uncertainty in the intelligence learning using different algorithms
5. Apply the machine learning process in handling unsupervised learning

UNIT I **9 Hours**

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

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 neighbors, advanced models, neural networks, SVMs, decision trees and unsupervised learning, handling software downtime. Markov decision processes and reinforcement learning, Logical Agent, propositional logic and first order logic

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. Deepak Khemani, "A First Course in Artificial Intelligence", Tata McGraw Hill, 2013
2. S. Russel and P.Norvig,"AI: A modern approach", 3rd Edition, Pearson Education, 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, New Delhi, 2011
5. Schalkoff, R.J., Artificial Intelligence: An Engineering Approach, McGraw-Hill, 2012

21IR58 INDUSTRIAL DATA NETWORKS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Select the basic data networks like ISO-OSI model and TCP/IP protocols
2. Analyze the concepts of inter-networking and serial communication
3. Compare the communication protocol devices such as HART and Field buses and its architecture & Topologies
4. Outline the MODBUS &Profibus communication models and its troubleshooting techniques and applications
5. 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, TCP IPv4 IPv6 basic structure format

UNIT II **9 Hours**

NETWORKING DEVICES

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

FOR FURTHER READING

Applications of wireless communication: Zigbee, WiFi, GPS, LiFi, Flexray

Total: 45 Hours

Reference(s)

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

21IR59 PROCESS CONSULTING AND PROJECT PLANNING

3 0 0 3

Course Objectives

- To apply basic foundation in project management methodologies, approaches, and process
- To analyse the different roles associated with project management
- To analyse key tools and techniques used in project management.

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Assess project contracts and compare the types of projects and contracts.
2. Implement planning and demonstrate the steps involved in planning.
3. Execute documentation for a given project using the documentation software
4. Compare the various purchase related activities ranging from material ordering to testing
5. Outline the various phases involved in project management and construct 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 Planning, controlling, analysing and forecasting projects 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), project 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 and critical path method (CPM), estimating activity time and total program time

FOR FURTHER READING

The Basic Project Management Process, Project Management Consulting, SRK &HoshinKanri methodology

Total: 45 Hours

Reference(s)

1. HarlodKerzner 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, 2019.
5. Willie Tan, Principles of Project and Infrastructure Finance, Taylor & Francis, 2011

21IR60 ROBOT ECONOMICS 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

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 & Return of Investments - 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 - Safety, Health and Medicine - Intellectual Property Internet, Communications, Data security 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 - Connected Robots via IoT, Interlocks, - Error Detection and Recovery - Robot Cycle Time Analysis - Economy, Development.

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. Mikell P. Groover, Mitchell weiss, Roger N. Nagel and Nicholas G.Odrey, Industrial Robotics, echnology 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. B.S. Dhillon. Robot Reliability and Safety, Springer New York, 2012
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, McGraw Hill Book Publications, 2015

21IR61 CONTROL SYSTEM 3 0 0 3

Course Objectives

- To develop linear models mainly state variable model and Transfer function model from NonLinear systems
- To make the students analyze linear systems in time domain and frequency domain with application of mathematics, science and engineering
- To emphasize the importance of drive based control and its related terminologies

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Design of 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'sgain 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

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

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

21IR62 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

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

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. To understand 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.

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.

Total: 45 Hours

Reference(s)

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.

21IR63 ELECTRICAL VEHICLE SYSTEMS 3 0 0 3

Course Objectives

- To understand the fundamentals of electrical motors and batteries
- To impart knowledge about electrical drives for electrical vehicle system
- To study the techniques underlying in building an electrical vehicle systems

Programme Outcomes (POs)

a. Carry out research/investigation and to independently solve problems related to the field of automation
b. Design and Automate the process by integrating robotics, mechanical engineering, electronic control and system concepts.
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Elucidate the concepts of electric, hybrid electric and plug-in hybrid electric vehicle (PHEV), their architecture, technologies and fundamentals
2. Apply the design, component sizing of the power electronics converters and various electric drives suitable for hybrid electric vehicles
3. Analyze different energy storage technologies used for hybrid electric vehicles and their control and energy balancing techniques
4. Investigate the different configurations of electric vehicles and charging techniques
5. Evaluate the control and configurations of HEV charging stations

UNIT I **8 Hours**

EV FUNDAMENTALS

Vehicle Basics, vehicle model, Vehicle Resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed, EV Powertrain Component Sizing..

UNIT II **9 Hours**

INTRODUCTION TO ELECTRIC PROPULSION UNIT

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

UNIT III **10 Hours**

ELECTRIC DRIVE TRAINS

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, DC-DC converters – buck converters – rectifiers - Inverters.

UNIT IV **9 Hours**

OPERATING SYSTEMS

BATTERIES AND ENERGY STORAGES

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries - Battery characterization, math modeling and designs - Battery sizing for various vehicle applications - Battery monitoring and charging control - Battery Management System

UNIT V **9 Hours**

EV CHARGING TECHNOLOGIES

Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging.

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley , 2019
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd. , 2009
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press , 2012
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press , 2012.
5. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010.

21XE01 ENGLISH FOR RESEARCH PAPER WRITING 2 0 0 0

Course Objectives

- Illustrate 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.

Programme Outcomes (POs)

c. Write and present a substantial technical report/document
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Illustrate the research ideas and writing journal papers
2. Creating research paper writing

UNIT I **6 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 **6 Hours**

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

UNIT III **6 Hours**

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

UNIT IV **6 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 **6 Hours**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

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.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

21XE02 COST MANAGEMENT OF ENGINEERING PROJECTS

2 0 0 0

Course Objectives

- To understand the cost concepts and different stages of project execution and its activities.
- To understand cost behavior, management and its quantitative techniques.

Programme Outcomes (POs)

c. Write and present a substantial technical report/document
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Apply the cost concepts in decision making.
2. Analyze the various stages of project execution and its activities.
3. Analyze the cost behavior and various types of costing.
4. Analyze the cost management and budget related decisions.
5. Analyze the quantitative techniques for cost management.

UNIT I **6 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 **6 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.

UNIT III **6 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 **6 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 **6 Hours**

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT

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

Total: 30 Hours

Reference(s)

1. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.
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

21XE03 STRESS MANAGEMENT 2 0 0 0

Course Objectives

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

Programme Outcomes (POs)

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

e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

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. Dos and Donts in life.i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

UNIT III **10 Hours**

Asan and Pranayam, i) Various yog 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.

21XE04 DISASTER MANAGEMENT 2 0 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

Programme Outcomes (POs)

e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

Course Outcomes (COs)

1. Illustrate the key concepts in disaster risk reduction and humanitarian response
2. Interpret 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 and Cyclones, Tsunamis and Floods, Droughts and Famines, Landslides and Avalanches Man-made disaster Nuclear Reactor Meltdown, Industrial Accidents and 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.

21XE05 VALUE EDUCATION 2 0 0 0

Course Objectives

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

Programme Outcomes (POs)

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

e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

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.

21XE06 PEDAGOGY STUDIES 2 0 0 0

Course Objectives

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

Programme Outcomes (POs)

c. Write and present a substantial technical report/document

f. Apply engineering principles to manage projects and to communicate effectively in interdisciplinary environments

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

21XE07 BUSINESS ANALYTICS 2 0 0 0

Course Objectives

- Illustrate 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

Programme Outcomes (POs)

c. Write and present a substantial technical report/document
d. Design components and systems related to industrial automation with realistic constraints such as economic, social, ethical, health and safety, manufacturability and sustainability
e. Exhibit research attitude, life-long learning and leadership quality in the broadest context of technological change.

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 **6 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 **6 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 **6 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 **6 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 **6 Hours**

DECISION ANALYSIS

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

Total: 30 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