M.E. (Instrumentation Engineering)

2018 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NBA New Delhi, NAAC with 'A' Grade and ISO 9001:2008 Certified)
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REGULATIONS 2018
(CHOICE BASED CREDIT SYSTEM)

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

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

1. ELIGIBILITY FOR ADMISSION

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

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

2. DURATION OF THE PROGRAMME

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

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

3. BRANCHES OF STUDY

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

M.E. Programmes

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

13. VLSI Design

M. Tech. Programme

14. Biotechnology

4. STRUCTURE OF PROGRAMMES

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

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

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

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

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

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

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

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

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

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

5. COURSE ENROLLMENT AND REGISTRATION

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

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

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

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

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

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

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

5.4 Minimum Credits to Register for Project work

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

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

5.5 Flexibility to Add or Drop courses

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

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

5.6 Reappearance Registration

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

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

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

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

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

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

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

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

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

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

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

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

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

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

7. FACULTY ADVISOR

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

8. COMMITTEES

8.1 Class Committee Meeting

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

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

9. ASSESSMENT AND PASSING REQUIREMENTS

9.1 Assessment

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

9.2 End Semester Examinations

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

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

9.3 Employability Enhancement Courses

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

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

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

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

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

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

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

Cumulative Grade Point Average is calculated using the formula:

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

where

C_i : Credit allotted to the course.

g_i : Grade Point secured corresponding to the course.

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

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

9.6 Passing a Course

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

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

10. REJOINING THE PROGRAMME

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

11. QUALIFYING FOR THE AWARD OF THE DEGREE

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

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

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

12. CLASSIFICATION OF DEGREE

12.1 First Class with Distinction:

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

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

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

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

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

12.2 First Class:

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

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

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

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

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

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

13. WITHDRAWAL FROM EXAMINATION

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

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

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

14. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

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

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

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

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

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

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

15. SCHEME OF ASSESSMENT

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

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

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

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

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

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

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

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

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

16. DISCIPLINE

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

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

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

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

M.E. – INSTRUMENTATION ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

I. Graduates will strengthen the knowledge in the domain of Instrumentation engineering and thereby performing important role in public/private organization and Institutes.

II. Graduates will hold the technical positions to identify and address current problems in the broad areas of Sensors, Instrumentation and Control Engineering.

III. Graduates will enhance the research attitude, article writing and lifelong learning in their professional field.

PROGRAM OUTCOMES (POS)

a) Graduate will able to carry out research /investigation and development activities to solve real time challenges

b) Graduate will able to demonstrate capability to design and development of instrumentation systems using modern engineering tools

c) Graduate will able to analyse the information required for developing the control schemes for linear and non linear system

d) Graduate will able to write and present a substantial technical report/document

e) Graduate will able to expertise in the field of Industrial Automation

f) Graduate will able to update the state of art techniques to enhance lifelong learning in the domain of Instrumentation & Control engineering

MAPPING OF PEOs AND POs

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

M.E. INSTRUMENTATION ENGINEERING

Minimum Credits to be Earned 69.0

FIRST SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IE11	MATHEMATICAL METHODS IN INSTRUMENTATION	I,II,III	a,b,c,d,f	3	0	0	3
18IE12	PROCESS DYNAMICS AND CONTROL	I,II,III	a,b,c,d,f	3	0	0	3
18IE13	TRANSDUCERS AND SMART INSTRUMENTS	I,II,III	a,b,c,d,e,f	3	0	0	3
18IE14	APPLIED INDUSTRIAL INSTRUMENTATION	I,II,III	a,b,c,e,f	3	0	0	3
	ELECTIVE I	-	-	3	0	0	3
	ELECTIVE II	-	-	3	0	0	3
18IE17	PROCESS DYNAMICS AND CONTROL LABORATORY	I,II,III	a,b,c,e,f	0	0	2	1
			Total	**18**	**0**	**2**	**19**
SECOND SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IE21	LINEAR AND NON-LINEAR SYSTEMS THOERY	I,II,III	a,b,c,d,f	3	0	0	3
18IE22	ADVANCED INDUSTRIAL AUTOMATION	I,II,III	a,b,c,e,f	3	0	0	3
18IE23	INSTRUMENTATION SYSTEM DESIGN	I,II,III	a,b,c,e,f	3	0	0	3
18IE24	WIRELESS SENSOR NETWORKS	I,II,III	a,b,c,d,e,f	3	0	0	3
	ELECTIVE III	-	-	3	0	0	3
	ELECTIVE IV	-	-	3	0	0	3
18IE27	INSTRUMENTATION SYSTEM DESIGN LABORATORY	I,II,III	a,b,c,d,e,f	0	0	2	1
18IE28	MINI PROJECT	I,II,III	a,b,c,d,e,f	0	0	2	1
	AUDIT COURSE I	-	-	2	0	0	0
			Total	**20**	**0**	**4**	**20**
THIRD SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IE31	APPLIED SOFT COMPUTING	I,II,III	a,b,c,d,f	3	0	0	3
	ELECTIVE V	-	-	3	0	0	3
	ELECTIVE VI	-	-	3	0	0	3
	ELECTIVE VII	-	-	3	0	0	3
18IE35	DISSERTATION PHASE I	I,II,III	a,b,c,d,e,f	0	0	12	6
	AUDIT COURSE II	-	-	2	0	0	0
			Total	**14**	**0**	**12**	**18**
FOURTH SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18IE41	DISSERTATION PHASE II	I,II,III	a,b,c,d,e,f	0	0	24	12
			Total	**0**	**0**	**24**	**12**

LIST OF CORE ELECTIVES							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**Pos**				
18IE51	RESEARCH METHODOLOGY AND IPR	I,II,III	a,b,c,d,f	3	0	0	3
18IE52	APPLIED BIOMEDICAL INSTRUMENTATION	I,II,III	a,b,c,d,f	3	0	0	3
18IE53	PROCESS CONTROL INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES	I,II,III	a,b,c,d,f	3	0	0	3
18IE54	INSTRUMENTATION IN FOOD TECHNOLOGY	I,II,III	a,b,c,e,f	3	0	0	3
18IE55	ENVIRONMENTAL INSTRUMENTATION	I,II,III	a,b,c,e,f	3	0	0	3
18IE56	AUTOMOBILE INSTRUMENTATION	I,II,III	a,b,c,d,f	3	0	0	3
18IE57	BUILDING AUTOMATION	I,II,III	a,b,c,d	3	0	0	3
18IE58	OPTIMAL CONTROL SYSTEM	I,II,III	a,b,c,d,f	3	0	0	3
18IE59	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	I,II,III	a,b,c,d,f	3	0	0	3
18IE60	DIGITAL CONTROL SYSTEM	I,II,III	a,b,c,d,f	3	0	0	3
18IE61	FAULT TOLERANT CONTROL	I,II,III	a,b,c,d,f	3	0	0	3
18IE62	DATA ANALYTICS	I,II,III	a,b,c,e,f	3	0	0	3
18IE63	DEEP LEARNING	I,II,III	a,b,c,d,e,f	3	0	0	3
18IE64	INSTRUMENTATION IN PAPER AND PULP INDUSTRIES	I,II,III	a,b,c,d,f	3	0	0	3
18IE65	MACHINE LEARNING	I,II,III	a,b,c,d,f	3	0	0	3
18IE66	INTERNET OF THINGS	I,II,III	a,b,c,e,f	3	0	0	3
18IE67	ADVANCES IN SENSING TECHNIQUES	I,II,III	a,b,c,e,f	3	0	0	3
18IE68	ROBOTICS AND AUTOMATION	I,II,III	a,b,c,e,f	3	0	0	3
18IE69	MICRO ELECTRO MECHANICAL SYSTEM	I,II,III	a,b,c,d,f	3	0	0	3
18IE70	POWER PLANT INSTRUMENTATION	I,II,III	a,b,c,d,f	3	0	0	3

LIST OF OPEN ELECTIVES							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18GE01	BUSINESS ANALYTICS			3	0	0	3
18GE02	INDUSTRIAL SAFETY			3	0	0	3
18GE03	OPERATIONS RESEARCH			3	0	0	3
18GE04	COST MANAGEMENT OF ENGINEERING PROJECTS			3	0	0	3
18GE05	COMPOSITE MATERIALS			3	0	0	3
18GE06	WASTE TO ENERGY			3	0	0	3

LIST OF AUDIT COURSE I							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18XE11	RESEARCH PAPER WRITING			2	0	0	0
18XE12	TRADITIONAL TECHNICAL KNOWLEDGE			2	0	0	0
18XE13	VALUE EDUCATION			2	0	0	0

LIST OF AUDIT COURSE II							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18XE21	STRESS MANAGEMENT			2	0	0	0
18XE22	DISASTER MANAGEMENT			2	0	0	0
18XE23	PEDAGOGY STUDIES			2	0	0	0

18IE11 MATHEMATICAL METHODS IN INSTRUMENTATION

3 0 0 3

Course Objectives

- Identify various algorithm design techniques.
- Impart knowledge on run time analysis of algorithms
- Empathize the limits of computation.

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Classify the fundamentals of Algorithmic problem solving methods based on Data Structures
2. Analyze the algorithm efficiency by means of mathematical notations
3. Develop different types of sorting and searching algorithms.
4. Analyze the different techniques in the design of Graph Algorithms.
5. Differentiate algorithms design techniques of NP complete with NP hard problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	2	1		1
2	2	1	1	1		2
3	2	2	1	1		2
4	2	2	1	2		1
5	1	2	2	2		2

UNIT I **7 Hours**

VECTOR SPACES AND TRANSFORMATION

Vector spaces, subspace and linear dependence, concept of basis, representation, norms of vectors and orthonormalization, Linear transformations, concept of symmetry, inner products, singular value decomposition.

UNIT II **9 Hours**

ORTHOGONAL AND UNITARY TRANSFORMATION

Orthogonal projections, products of projections, orthogonal direct sums, Unitary and orthogonal transformations, closed subspaces and the projection theorem for Hilbert spaces

UNIT III **10 Hours**

NUMERICAL METHOD FOR ALGEBRAIC AND DIFFERENTIAL EQUATIONS

Least square method, Gauss-Jordon method, Gauss-Seidal method, Gauss elimination method, Newton-Raphson method, Euler's method, modified Euler's method, Runge-Kutta methods, Adam-Bashforth method, solution for fractional order differential equation.

UNIT IV **10 Hours**

BASIC CONCEPT OF PROBABILITY AND PROBABILITY DISTRIBUTIONS

Random experiments, sample spaces, axioms of probability, conditional probability, Bayes theorem, Probability distribution function, probability density function, Binomial, Normal, Poisson and uniform distribution

UNIT V **9 Hours**

MATHEMATICAL EXPECTATIONS

Distribution function-Expectation with properties-Moments, mean, Variance, standard deviation covariance and correlation, problems for continuous and discrete distributions.

Total: 45 Hours

Reference(s)

1. Chen C. T., Linear Systems: Theory & Design, (Oxford University Press New York), (1999).
2. Charles W. Curtis, Linear Algebra: An Introductory Approach (Springer (India) Pvt. Ltd.), (2004).
3. Strang G.,Linear Algebra And Its Applications. (Thomson Brooks, Australia), (1998).
4. Lay D. C., Linear Algebra and Applications, (Addison Wesley, Massachusetts), (1996).
5. Gilbert Jimmie and Gilbert Linda,Linear Algebra and Matrix TheoryElsevier India Publishing Co., New Delhi, (2005).
6. Grewal B. S Higher Engineering MathematicsKhanna Publishers, New Delhi), (2004).

18IE12 PROCESS DYNAMICS AND CONTROL 3 0 0 3

Course Objectives

- To obtain the mathematical model of first order systems and understand about the controllers and controller tuning methods.
- To get knowledge about various complex control schemes, multivariable systems and multivariable control schemes for various applications.
- To elaborate different types of control schemes such as cascade control, feedforward control etc.

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Analyse the mathematical models for first order real-time systems and understand the characteristics of various control modes.
2. Design controller tuning parameters using various methods and understand the concept of various complex control schemes
3. Interpret about the multivariable systems and understand the procedure to apply the multivariable control schemes for simple applications
4. Identify unit operations used in different industries
5. Analyse different unit operations in various industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	2	1		2
2	1	2	1	2		1
3	3	2	1	2		2
4	2	3	1	2		2
5	2	2	2	3		2

UNIT I **10 Hours**

PROCESS DYNAMICS

Need for process control Hierarchical decomposition of control functions - Continuous and batch processes - P&ID diagram - Self regulation - Interacting and non-interacting systems - Mathematical model of first order Level, Flow and Thermal processes Lumped and Distributed parameter models - Linearization of nonlinear systems - Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes - Digital PID algorithm Auto/manual transfer - Reset windup Practical forms of PID Controller.

UNIT II **8 Hours**

PID CONTROLLER TUNING AND SINGLE LOOP REGULATORY CONTROL

Evaluation criteria - IAE, ISE, ITAE and decay ratio - Tuning: - Process reaction curve method:- Z-N and Cohen-Coon methods, Continuous cycling method and Damped oscillation method and optimization methods - Auto tuning - Cascade control - Split-range - Feed-forward control - Ratio control - Inferential control - override control - Smith predictor control scheme - Internal Model Controller - IMC PID controller - Single Loop Dynamic Matrix Control - Generalized Predictive Control

UNIT III **10 Hours**

MULTIVARIABLE SYSTEMS

Multivariable Systems - Transfer Matrix Representation - Poles and Zeros of MIMO System - Multivariable frequency response analysis - Directions in multivariable systems - Singular value decomposition - Multi-loop Control - Introduction - Process Interaction - Pairing of Inputs and Outputs - The Relative Gain Array (RGA) - Properties and Application of RGA - Multi-loop PID Controller - Biggest Log Modulus Tuning Method - Decoupling Control

UNIT IV **8 Hours**

MULTIVARIABLE REGULATORY CONTROL

Introduction to Multivariable control - Multivariable PID Controller - Multivariable IMC - Multivariable Dynamic Matrix Controller - Multiple Model based Predictive Controller - Predictive PID Control - Control Schemes for Distillation Column, CSTR, Bioreactor, Four-tank system, pH, and polymerization reactor.

UNIT V **9 Hours**

UNIT OPERATIONS IN DIFFERENT INDUSTRIES

Identification and justification of unit operations used in different industries like food, pharma, paper, sugar, cement, fertilizer, Petrochemical industry with help of process flow diagram. Design aspects and control scheme development for Waste-Water Treatment plant

Total: 45 Hours

Reference(s)

1. B.WayneBequette, Process Control: Modeling, Design, and Simulation, Prentice Hall of India, 2004
2. Dale E. Seborg , Duncan A. Mellichamp , Thomas F. Edgar, and Francis J. Doyle, III Process Dynamics and Control, John Wiley and Sons, 3rd Edition, 2010
3. Jose A. Romagnoli and AhmetPalazoglu , Introduction to Process Control, CRC Press, Taylor and Francis Group, Second Edition, First Indian Reprint, 2010
4. Coleman Brosilow and Babu Joseph, Techniques of Model-based Control, Prentice Hall International Series, PTR, New Jersey, 2001
5. F. G. Shinskey, Process Control Systems, Tata-McGraw Hill.
6. Coleman Brosilow and Babu Joseph, "Techniques of Model-based Control", Prentice Hall International Series, PTR, New Jersey, 2001.

18IE13 TRANSDUCERS AND SMART INSTRUMENTS 3 0 0 3

Course Objectives

- To provide a detailed knowledge on transducer characteristics, error analysis and uncertainties measurement.
- To impart a comprehensive knowledge on smart sensor design and recent trends in sensor technologies
- To understand the basics of micro fabrication and various micro sensors and actuators.

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the concept of conventional transducers and its characteristics
2. Analyze the errors and uncertainties in measurement data
3. Analyze the errors and uncertainties in measurement data
4. Interpret the manufacturing techniques and design aspects of micro sensors and actuators
5. Identify comprehensive knowledge of recent trends in sensor technologies

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	3	2		3
2	2	1	3	2		1
3	3	2	1	2		2
4	2	2	1	3		2
5	1	2	2	-	2	3

UNIT I **8 Hours**

OVERVIEW OF CONVENTIONAL TRANSDUCERS CHARACTERISTICS AND CALIBRATION

Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric, Magneto strictive proximity and Hall effect sensors - Static and Dynamic Characteristics and specifications - Calibration standards - Calibration of differential pressure transmitters

UNIT II **10 Hours**

MEASUREMENT ERROR AND UNCERTAINTY ANALYSIS

Importance of error analysis - Uncertainties, precision and accuracy in measurement -Random errors - Distributions, mean, width and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem - Error propagation - single and multi-variable functions - Data visualization and reduction - Least square fitting of complex functions

UNIT III **9 Hours**

SMART SENSORS

Integrated smart sensors - definition - Universal Sensor Interface - High precision amplifier ICs and filter ICs - DAQ board design - Digital conversion techniques - Microcontrollers and digital signal processors for smart sensors - selection - Timer - ADC and DAC modules - Standards for smart sensor interface - Smart Transmitters

UNIT IV **9 Hours**

MICRO SENSORS AND ACTUATORS

Micro system design and fabrication - Micro pressure sensors (Piezo resistive and Capacitive) - Resonant sensors - Acoustic wave sensors - Bio micro sensors - Micro actuators - Micro mechanical motors and pumps- Introduction to Nano sensors

UNIT V **9 Hours**

RECENT TRENDS IN SENSOR TECHNOLOGIES

Thick film and thin film sensors - Soft sensor - Electro chemical sensors - RFIDs - Sensor arrays - Sensor network - Multisensor data fusion

Total: 45 Hours

Reference(s)

1. Ernest O Doebelin and Dhanesh N Manik, Measurement Systems Application and Design, 5th Edition, Tata Mc-Graw Hill, 2011
2. Ifan G. Hughes and Thomas P.A. Hase, Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis, Oxford University Press, 2010
3. Gerord C.M. Meijer, Smart Sensor Systems, John Wiley and Sons, 2010
4. Tai Ran Hsu, MEMS & Micro systems: Design, Manufacture and Nanoscale Engineering, Tata McGraw Hill, New Delhi, 2011
5. D. Patranabis, Sensors and Transducers, Second Edition, PHI Publication, New Delhi, 2010

18IE14 APPLIED INDUSTRIAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To enable the students to acquire knowledge about the various techniques used for the measurement of primary industrial parameters and parameters to be monitored and analyzed in thermal power plant and petroleum refinery.
- To acquire knowledge in industrial safety and special purpose instrumentation.
- To get an exposure on the important parameters to be monitored and analyzed in pulp and paper industries.
- To get an exposure on reliability engineering

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the hazardous zone classification in industries.
2. Identify appropriate installation techniques in Power plant and petroleum refineries.
3. Classify the intrinsic safety techniques to the adapted in industries
4. Interpret the reliability engineering and reduce the failure rate in industries to increase the productivity.
5. Compare the special purpose instruments like analyzers, detectors, instrumentation for NDT applications etc.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	3		3	2
2	2	1	1		3	2
3	2	2	1		2	3
4	1	2	3		2	2
5	2	2	3		1	2

UNIT I **7 Hours**

REVIEW OF INDUSTRIAL INSTRUMENTATION

Measurement of Force, Torque, Acceleration, Pressure, Temperature, Flow, Level, Humidity & Moisture.

UNIT II **9 Hours**

MEASUREMENT IN THERMAL POWER PLANT AND PETROLEUM REFINERY

Selection and Installation of instruments used for the Measurement of flow, level, pressure and temperature - Feed water quality measurement- Flue gas Oxygen Analyzers- Hydrocarbon analyzers.

UNIT III **11 Hours**

INSTRUMENTATION FOR INDUSTRIAL SAFETY AND SPECIAL PURPOSE INSTRUMENTATION

Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems - Conservation and emergency vents - Flame, fire and smoke detectors - Instrumentation for NDT applications

UNIT IV **9 Hours**

INSTRUMENTATION FOR PULP AND PAPER INDUSTRIES

Definition of consistency - Techniques for head box consistency measurement -Functioning of Paper making machine - Quality parameters - moisture, basic weight, calliper, brightness, colour, ash content, strength, gloss and tensile strength - parameters monitoring Instrumentation

UNIT V **9 Hours**

RELIABILITY ENGINEERING

Definition of reliability - reliability and the failure rate - relation between reliability and MTBF - MTTR - maintainability - availability - series and parallel systems.

Total: 45 Hours

Reference(s)

1. B.G.Liptak, Instrumentation Engineers Handbook (Process Measurement & Analysis), Fourth Edition, Chilton Book Co, 2013.
2. K.Krishnaswamy and M.Ponnibala, Power Plant Instrumentation, PHI Learning Pvt Ltd, 2011.
3. John G. Webster, Halit Eren, “The Measurement Instrumentation and Sensors Handbook”, CRC and IEEE Press, Second Edition 2014.
4. D.Patranabis, Principles of Industrial Instrumentation Tata McGraw Hill Publishing Company Limited. New Delhi, 2010.
5. Paul E. Mix, “Introduction to Non-destructive Testing”, John Wiley and Sons, 2005
6. Smith, D.J., Reliability Engineering, Pitman, 1972.

18IE17 PROCESS DYNAMICS AND CONTROL LABORATORY

0 0 2 1

Course Objectives

- To determine the mathematical model and characterize the control valves for various non linear system
- To obtain and control closed loop response for non linear system
- To determine the mathematical model and characterize the control valves for various non linear system

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Analyse the closed loop response of process variables
2. Implement the optimization techniques of cylindrical tank systems
3. Execute the series and parallel PID controller
4. Analyse the flow characteristics of control valves
5. Analyse the mathematical modelling of Interacting and Non-Interacting systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1		2		2	
2		3		-	3	
3		3	2			3
4			2		2	3
5		2	3		2	

1 **3 Hours**

EXPERIMENT 1

Closed loop response of level process in spherical tank system.

2 **3 Hours**

EXPERIMENT 2

Closed loop response of air flow temperature process.

3 **3 Hours**

EXPERIMENT 3

Simulation of closed loop response of series

4 **3 Hours**

EXPERIMENT 4

Optimization of PID controller parameter using Genetic algorithm

5 **3 Hours**

EXPERIMENT 5

Mathematical modelling of inverting and noninverting cylindrical tank system.

6 **3 Hours**

EXPERIMENT 6

Flow lift characteristics of different types of control valves.

7 **3 Hours**

EXPERIMENT 7

Closed loop response of single conical system.

8 **3 Hours**

EXPERIMENT 8

Closed loop response of compressed air pressure station.

9 **3 Hours**

EXPERIMENT 9

Modern optimization of single cylindrical tank system with Fmin- search Fmin- con using MATLAB.

10 **3 Hours**

EXPERIMENT 10

Implementation of cascade control for Continuous Stirrer Tank Heater(CSTH) system.

Total: 30 Hours

18IE21 LINEAR AND NON-LINEAR SYSTEMS THOERY

3 0 0 3

Course Objectives

- To impart knowledge and skills needed to classify singular points and construct phase trajectory using delta and isocline methods
- To understand the concepts of stability and techniques to assess the stability of certain class of non-linear system
- To familiarize the various non-linear behaviours such as Limit cycles, Bifurcation and Chaos

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Interpret the time-invariant systems in state space form
2. Analyze, whether the system is stabilizable, controllable, observable and detectable
3. Identify the nonlinear system sand to develop a control scheme
4. Interpret the concepts of stability of nonlinear systems
5. Analyze the stability of the nonlinear systems by using various techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	2	2		2
2	2	2	1	1		1
3	2	1	2	1		2
4	2	3	1	2		3
5	2	3	2	3		2

UNIT I **9 Hours**

STATE SPACE APPROACH

Review of state model for systems Non uniqueness of state model Role of Eigen values and Eigen vectors -State transition matrix and its properties free and forced responses State Diagrams - minimal realization balanced realization

UNIT II **9 Hours**

STATE FEEDBACK CONTROL AND STATE ESTIMATOR

Controllability and observability Stabilizability and Detectability Kalman Decomposition State Feedback Pole placement technique Full order and reduced order observers

UNIT III **9 Hours**

NON-LINEAR SYSTEMS

Types of Non-Linearity Typical Examples Singular Points Phase plane analysis (analytical and graphical methods) Limit cycles Equivalent Linearization Describing Function Analysis, Derivation of describing functions for different non-linear elements

UNIT IV **9 Hours**

STABILITY OF NON-LINEAR SYSTEMS

Stability concepts Equilibrium points BIBO and Asymptotic stability Stability Analysis by DF method Lyapunov Stability Criteria Krasovskilsmethod Variable Gradient Method Popov Stability Criterion Circle Criterion

UNIT V **9 Hours**

NON-LINEAR SYSTEMS ANALYSIS

Bifurcation behaviour of Single ODE Systems: - Motivation, Illustration of Bifurcation behaviour and types of bifurcations - Bifurcation behaviour of two-state systems: - Dimensional bifurcations in the phase-plane, Limit cycle behaviour and Hoof Bifurcation -Introduction to Chaos: The Lorenz Equations, Stability analysis of the Lorenz Equations, Numerical study of the Lorenz Equations, Chaos in chemical systems and other issues in Chaos

Total: 45 Hours

Reference(s)

1. Curtis. D. Johnson, “Process Control Instrumentation Technology”, 8th edition, Pearson Education Limited, 2013
2. Philip L.Skousen, “Control Valve Handbook” 3rd edition, Fisher Controls International, 2011
3. Bela G. Liptak, Instrument Engineers Handbook - Process Software and Digital network, 4th edition, CRC Press, 2011
4. Andrew Williams, “Applied Instrumentation in the process industries” 2nd edition, Gulf Publishing company, 2010
5. Marc Hellemans, “The Safety relief valve Handbook", 1st edition, Elsevier Ltd, 2010

18IE22 ADVANCED INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

- To understand the various automation hardware for the given application.
- To review various control aspects of automation
- To obtain knowledge about capability of Industrial Automation

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Identify suitable automation transfer line for the given application
2. Describe & explain potential areas of automation.
3. Differentiate various control aspects of automation.
4. Demonstrate the self learning capability of Industrial Automation.
5. Select suitable automation hardware for the given application

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	3	2		3	3
2	2	2	3		3	3
3	2	3	2		3	2
4	1	2	2		2	3
5	1	2	3		2	2

UNIT I **9 Hours**

INTRODUCTION

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 of Transfer Lines.

UNIT II **9 Hours**

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES

Overview of Material Handling Systems - Principles and Design Consideration - Material Transport Systems - Storage Systems - Overview of Automatic Identification Methods.

UNIT III **10 Hours**

AUTOMATED MANUFACTURING SYSTEMS

Components - Classification and Overview of Manufacturing Systems - Manufacturing Cells - GT and Cellular Manufacturing - FMS - FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods - SPC Tools - Inspection Principles and Practices - Inspection Technologies.

UNIT IV **9 Hours**

CONTROL TECHNOLOGIES IN AUTOMATION

Industrial Control Systems - Process Industries Versus Discrete-Manufacturing Industries - Continuous Versus Discrete Control - Computer Process and its Forms

UNIT V **8 Hours**

MODELING AND SIMULATION FOR PLANT AUTOMATION

Introduction - need for system Modeling - Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement - Thermal - Water Treatment & Steel Plants. SLE: Cases Studies minimum one for Cement - Thermal - Water Treatment & Steel Plants applications

Total: 45 Hours

Text Book(s)

1. Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.5th edition, 2009.

Reference(s)

1. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010
2. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk
3. Performance Modeling of Automated Manufacturing Systems,-Viswanandham, PHI, 1st edition,2009.

18IE23 INSTRUMENTATION SYSTEM DESIGN 3 0 0 3

Course Objectives

- To design and analyse various circuits for Industrial primary devices
- To study the standard symbol of instrumentation system and design of piping and instrumentation diagram

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Design and analyse various circuits for Industrial primary devices.
2. Analyse the standard symbol of instrumentation system and design of piping and instrumentation diagram
3. Implement various controller designs, and methods for controller tuning
4. Identify various field instruments.
5. Design alarm circuit for various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	3		2	2
2	2	3	1		2	3
3	2	2	2		2	2
4	3	2	2		1	2
5	3	1	2		1	1

UNIT I **9 Hours**

DESIGN OF SIGNAL CONDITIONING CIRCUITS

Design of V/I Converter and I/V Converter - Analog and Digital filter design and Adaptive filter design - Signal conditioning circuit for pH measurement, Air-purge Level Measurement - Signal conditioning circuit for Temperature measurement: Thermocouple, RTD and Thermistor - Cold Junction Compensation and Linearization - software and hardware approaches

UNIT II **9 Hours**

DESIGN OF TRANSMITTERS

Introduction to 2 wire and 4 wire transmitters - Design of RTD based Temperature Transmitter, Thermocouple based Temperature Transmitter and Capacitance based Level Transmitter and Smart Flow Transmitters

UNIT III **9 Hours**

DESIGN OF DATA LOGGER AND PID CONTROLLER

Design of ON/OFF Controller using Linear Integrated Circuits - Electronic PID Controller - Microcontroller based Digital Two-degree of freedom PID Controller - Microcontroller based Data Logger - Design of PC based Data Acquisition Cards

UNIT IV **9 Hours**

ORIFICE AND CONTROL VALVE SIZING

Orifice, Venturi and flow nozzle Sizing - Liquid, Gas and steam services - Control valve Sizing - Liquid, Gas and steam Services - Rotameter Design.

UNIT V **9 Hours**

DESIGN OF ALARM AND ANNUNCIATION CIRCUIT

Alarm and Annunciation circuits using Analog and Digital Circuits - Design of Programmable Logic Controller - Design of configurable sequential controller using PLDs

Total: 45 Hours

Reference(s)

1. C. D. Johnson, “Process Control Instrumentation Technology”, 8th Edition, Prentice Hall, 2012
2. Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2013.
3. R.W. Miller, “Flow Measurement Engineering Handbook”, Mc-Graw Hill, New York 2011.
4. Bela G. Liptak, “Instrument Engineers Handbook - Process Control and Optimization”, 4th Edition, Vol.2, CRC Press, 2012.

18IE24 WIRELESS SENSOR NETWORKS 3 0 0 3

Course Objectives

- To obtain a broad understanding of the technologies and applications for the emerging and exciting domain of wireless sensor networks
- To study the challenges and latest research results related to the design and management of wireless sensor networks
- To focus on network architectures and security

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Formulate the basics of wireless sensor networks and its applications in enabling technologies
2. Indicate the architecture and elements of wireless sensor networks
3. Identify the performance of MAC and routing protocols
4. Implement the localization techniques for detection WSN
5. Demonstrate the tools and platforms needed to establish sensor networks

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	2		1	2
2	2	3	2		1	3
3	2	3	1		2	2
4	2	2	1		2	2
5	1	3	2	2		2

UNIT I **9 Hours**

OVERVIEW OF WIRELESS SENSOR NETWORKS

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- Enabling Technologies for Wireless Sensor Networks.

UNIT II **9 Hours**

ARCHITECTURES

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts, Case study: Structural Health Monitoring-Environmental Sensor Networks.

UNIT III **9 Hours**

DESIGN OF DATA LOGGER AND PID CONTROLLER

Design of ON/OFF Controller using Linear Integrated Circuits - Electronic PID Controller - Microcontroller based Digital Two-degree of freedom PID Controller - Microcontroller based Data Logger - Design of PC based Data Acquisition Cards

UNIT IV **9 Hours**

INFRASTRUCTURE ESTABLISHMENT

Topology Control, Clustering, Time Synchronization, Localization and Positioning-case study: Shooter Localization in Urban Terrain, Sensor Tasking and Control-Case study: Large Scale Habitat Monitoring. Security and privacy protection, Heterogeneous fault detection, Discrepancy based fault detection and correction, Case study: Secure Routing in Wireless Sensor Networks: Attacks and Countermeasures

UNIT V **9 Hours**

SENSOR NETWORK PLATFORMS AND TOOLS

Operating Systems for Wireless Sensor Networks, Sensor Node Hardware - Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming, Case study: Qualnet Simulation of Military application.

Total: 45 Hours

Reference(s)

1. C. D. JohnsonProcess Control Instrumentation Technology 8th Edition, Prentice Hall, 2012.
2. Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2013.

3. R.W. Miller, Flow Measurement Engineering HandbookMc-Graw Hill, New York 2011.
4. Bela G. Liptak, Instrument Engineers Handbook - Process Control and Optimization 4th Edition, Vol.2, CRC Press, 2012.
5. K. Martinez, J. Hart and R. Ong, Environmental Sensor Networks IEEE Computer Magazine, August 2004.
6. 6. M. Maroti, G. Simon, A Ledeczi and J. Sztipanovits, Shooter Localization in Urban Terrain, IEEE Computer Magazine, August 2004.

18IE27 INSTRUMENTATION SYSTEM DESIGN LABORATORY

0 0 2 1

Course Objectives

- To design converters and signal conditioning circuit for instrumentation systems
- To perform detailed calibration process for flow transmitter
- To formulate P&ID diagram for given instrumentation system

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Design signal conditioning circuits and converters for given instrumentation system
2. Design PID controller, alarm and annunciation circuit using analog circuits
3. Design linearization circuit for given thermocouple using analog circuits
4. Create P&ID diagram for given instrumentation system
5. Analyse various field instruments and control scheme

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	3	3		1
2	2	2	1	2		1
3	1	2	2	2		2
4	2	3	2	2		3
5	3	1	2	2		1

1 **3 Hours**

EXPERIMENT 1

Design of instrumentation amplifier using Op-amp

2 **3 Hours**

EXPERIMENT 2

Design of analog and digital filters using analog circuit and MATLAB

3 **3 Hours**

EXPERIMENT 3

Design of V/I and I/V converters for 0-5, 0-10 Volt to 4-20mA and vice versa using analog IC's

4 **3 Hours**

EXPERIMENT 4

Design of linearization circuit and cold - junction compensation circuit for thermocouple based temperature measurement

5 **3 Hours**

EXPERIMENT 5

Design of signal conditioning circuit for strain gauge and RTD

6 **3 Hours**

EXPERIMENT 6

Calibration of Differential Pressure Transmitter using HART communicator

7 **3 Hours**

EXPERIMENT 7

Characteristics of I to P and P to I converter

8 **3 Hours**

EXPERIMENT 8

Design of Electronic PID controllers (using operational amplifier and microcontroller)

9 **3 Hours**

EXPERIMENT 9

Design of Alarm and annunciation circuit using analog circuit

10 **3 Hours**

EXPERIMENT 10

Piping and Instrumentation Diagram - case study

Total: 30 Hours

18IE28 MINI PROJECT 0 0 2 1

Course Objectives

- Formulate a real world problem, identify the requirement and develop the design solutions
- Identify technical ideas, strategies and methodologies
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project

- Test and validate through conformance of the developed prototype and analysis the cost effectiveness
- Prepare report and present oral demonstrations

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solution
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
4. Perform test and validate through conformance of the developed prototype and analysis the cost effectiveness
5. Explain the acquired knowledge through preparation of report and oral presentations

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3			3		3
2	3	3		2		3
3	3	3		3	3	3
4	2	3	2	3	2	3
5	3	3	3	3	2	3

3 0 0 3

18IE31 APPLIED SOFT COMPUTING

Course Objectives

- To expose the students to the concepts of feed forward neural networks
- To provide adequate knowledge about fuzzy and neuro-fuuzy systems
- To provide adequate knowledge of genetic algorithms and its application to economic dispatch and unit commitment problems

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Implement machine learning through neural networks
2. Infer different learning methods in neural networks
3. Develop a fuzzy expert system
4. Classify neuro fuzzy system for clustering
5. Design Genetic algorithm to solve optimization problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	2		2
2	1	2	1	1		1
3	2	3	2	3		3
4	2	1	3	2		3
5	1	2	3	3		3

UNIT I **9 Hours**

INTRODUCTION TO SOFT COMPUTING

Evolution of Computing - Soft Computing Constituents - From Conventional AI to Computational Intelligence - Machine learning Basics.

UNIT II **9 Hours**

NEURAL NETWORKS

Machine Learning using Neural Network, Adaptive Networks - Feed Forward Networks - Supervised Learning Neural Networks - Radial Basis Function Networks - Reinforcement Learning - Unsupervised Learning Neural Networks - Adaptive Resonance Architectures - Advances in Neural Networks.

UNIT III **9 Hours**

FUZZY LOGIC

Fuzzy sets - Operations on Fuzzy Sets - Fuzzy Relations - Membership Functions - Fuzzy Rules and Fuzzy Reasoning - Fuzzy Inference Systems - Fuzzy Expert Systems - Fuzzy Decision Making.

UNIT IV **9 Hours**

NEURO - FUZZY MODELING

Adaptive Neuro - Fuzzy Inference systems - Coactive Neuro-Fuzzy Modeling - Classification and Regression Tress - Data Clustering Algorithms - Rule base structure Identification - Neuro-Fuzzy Control

UNIT V **9 Hours**

GENETIC ALGORITHMS

Introduction - Gradient Search - Non-gradient search - Genetic Algorithms: binary and real representation schemes, selection methods, crossover and mutation operators for binary and real coding.

Total: 45 Hours

Reference(s)

1. Timothy J. Ross, Fuzzy Logic with Engineering Applications, 3rd Edition, Wiley India Edition, 2011
2. S.N.Sivanandam and S.N.Deepa, Principles of Soft computing, 2nd Edition, Wiley India Edition, 2013
3. David E. Goldberg, Genetic Algorithms in search, optimization and machine learning, Addison Welsey, 2010
4. Laurance Fausett, Englewood cliffs, N.J., Fundamentals of Neural Networks, Pearson Education, 2010
5. Hagan, Demuth, Beale, Neural Network Design, Cengage Learning, 2012
6. N.P.Padhy, Artificial Intelligence and Intelligent Systems, Oxford, 2013

18IE35 DISSERTATION PHASE - I 0 0 12 6

Course Objectives

- To understand some basic concepts of engineering research and its methodologies
- To identify various sources of information for literature review and data collection.
- To families the various procedures to formulate appropriate research problem and design of experiments

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

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

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	3	2	3
2	3	3	2	3	3	3
3	3	3	2	3	3	3
4	3	2	3	3	2	3
5	3	2	3	3	3	3

18IE41 DISSERTATION PHASE - II 0 0 24 12

Course Objectives

- Formulate a real world problem, identify the requirement and develop the design solutions
- Identify technical ideas, strategies and methodologies
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness
- Prepare report and present oral demonstrations

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

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

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3

18IE51 RESEARCH METHODOLOGY AND IPR 3 0 0 3

Course Objectives

- Recognizing the ensuing knowledge as property
- Create consciousness for Intellectual Property Rights and its constituents
- Perform documentation and administrative procedures relating to IPR in India as well as abroad.
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

Programme Outcomes (POs)

a. carry out research /investigation and development work to solve practical problems
b. write and present a substantial technical report/document
c. demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
d. exploit the techniques, skills and modern engineering tools which are essential for analysing the real world problems in embedded system technologies.

Course Outcomes (COs)

1. Understand research problem formulation
2. Analyze research related information and follow research ethics
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2	2		
2	3	1	2			
3	3	1	2			
4	3	1	2	2		
5	3	1		2		

UNIT I **9 Hours**

RESEARCH PROBLEM FORMULATION

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, Necessary instrumentations

UNIT II **9 Hours**

THESIS PREPARATION

Effective literature studies approaches, analysis Plagiarism, and Research ethics.

UNIT III **7 Hours**

PROPOSAL WRITING

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 IV **10 Hours**

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. Procedure for grants of patents, Patenting under PCT.

UNIT V **10 Hours**

PATENT RIGHTS & NEW DEVELOPMENTS IN IPR

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total: 45 Hours

Reference(s)

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students.
2. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction.
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners, 2nd Edition.
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, 2007.
5. Mayall, Industrial Design, McGraw Hill, 1992.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, 2016.

18IE52 APPLIED BIOMEDICAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To understand the role of instrumentation in biomedical engineering field
- To get ample knowledge on Electro-physiological and non-electric parameter measurement
- To analyze parameters of medical imaging and its measurements

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. Analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Analyze the human physiology and characterize the different transducers to measure its parameters
2. Classify the various Electro physiological and blood flow measurements
3. Identify the techniques for heart and blood pressure measurements
4. Construct the techniques used in medical image analysis
5. Choose the appropriate assistive and Therapeutic devices for Illness

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	1		2
2	3	2	3	2		2
3	2	3	1	3		2
4	1	2	2	3		2
5	2	3	1	2		1

UNIT I **10 Hours**

HUMAN PHYSIOLOGY AND BIO POTENTIAL ELECTRODES

Cell and their structures - action and resting potential - nervous system: functional organization of the nervous system, structure of nervous system, neurons, synapse - transmitters and neural communication - cardiovascular system - basic components of a biomedical system - different types of electrodes - electrical safety - grounding and isolation

UNIT II **9 Hours**

ELECTRO - PHYSIOLOGICAL AND BLOOD FLOW MEASUREMENT

ECG - EEG - lead system and recording methods - typical waveforms - Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

UNIT III **9 Hours**

NON - ELECTRICAL PARAMETER MEASUREMENT

Measurement of blood pressure - Heart rate - Heart sound - Pulmonary function measurements - spirometer - Body Plethysmograph - Blood Gas analyzers: pH of blood - measurement of blood pCO2, pO2, pulse oximeter

UNIT IV **9 Hours**

MEDICAL IMAGING PARAMETER MEASUREMENTS

X-RAY machine - Computer Tomography - Magnetic Resonance Imaging system - ultra sonography - Endoscopy - bio-telemetry

UNIT V **8 Hours**

ASSISTING AND THERAPEUTIC DEVICES

Cardiac pacemakers - defibrillators - ventilators - heart lung machine - dialysers - elements of audio and visual aids; Case Study

Total: 45 Hours

Reference(s)

1. R.S.Khandpur, Hand Book of Bio-Medical instrumentation, Tata McGraw Hill publishing company Ltd., 2014.
2. J.G. Webster, Medical Instrumentation: Application and Design, John Wiley and Sons, New York, 2014.
3. Leslie Cromwell, Biomedical Instrumentation and measurement, Tata McGraw Hill, 2012.
4. G. Well, Biomedical Instrumentation and Measurements, Prentice Hall of India, New Delhi, 2012.

18IE53 PROCESS CONTROL INSTRUMENTATION IN PETROCHEMICAL INDUSTRIES

3 0 0 3

Course Objectives

- To understand the process involved in petroleum refineries
- To impact adequate knowledge on the distillation column and its control process
- To understand the controlling concepts of major unit of refineries like distillation column, different types of reactors and driers.
- To understand the temperature controlling concepts of major unit of refineries like heat exchangers, various types of evaporators with control techniques.
- To be acquainted with the safety measures in petroleum industries

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the scenario of the production and consumption of fossil fuels in India.
2. Indicate the process involved in Petrochemical refinery industry
3. Apply the various conversion processes through measuring instruments.
4. Interpret the importance of controlling the various parameters and enhance the knowledge on usage of safety instrumentation to avoid the accidents in industries.
5. Analyze intrinsic safety various industrious zones

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	2	2		2
2	2	3	1	2		3
3	3	1	2	2		1
4	1	2	2	3		2
5	2	3	2	3		2

UNIT I **9 Hours**

INTRODUCTION

Petroleum formation and exploration, production and refining, separation of gas and water from oil - control loops in oil gas separator, constituents of crude oil.

UNIT II **9 Hours**

PROCESS IN PETROCHEMICAL INDUSTRIES

Introduction to P & I diagram- P&I diagram for distillation process - atmospheric and vacuum distillation process, Blending process thermal conversion process -control of distillation column -temperature control - process control -feed control - reflux control- reboiler control

UNIT III **9 Hours**

REACTORS IN PETROCHEMICAL INSUTRIES

Control of chemical reactors: temperature control, pressure control - control of dryers - batch dryers - atmospheric and vacuum dryers - continuous dryers

UNIT IV **9 Hours**

HEAT EXCHANGE SYSTEM IN INDUSTRIES

Control of heat exchangers and evaporators - variables and degrees of freedom - liquid to liquid heat exchangers - steam heaters - condensers - reboiler and vaporizers - cascade control - feed forward control -evaporators: types of evaporators

UNIT V **9 Hours**

SAFETY INSTRUMENTATION

Hazardous and non-hazardous area -classification of zone 0, zone 1 & zone 2 - pressurization techniques - zener barrier-Mechanical and Electrical isolation - Area and material classification as per National Electric Code (NEC)

Total: 45 Hours

Reference(s)

1. Ram Prasad, Petroleum Refining Technology, Khanna Publishers Ltd, New Delhi, 2000
2. B.G. Liptak, Instrumentation in Process Industries, Chilton Book Company, New York,1973
3. B.G. Liptak, Instrument Engineers Handbook Volume II, 2003

18IE54 INSTRUMENTATION IN FOOD TECHNOLOGY

3 0 0 3

Course Objectives

- To provide exposure to various techniques and methods that occurs in the various regions of food analysis
- To identify various sources of information for literature review and data collection.
- To understand the concepts of electrodes and biosensors that has potential applications in food and beverage industries

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Exemplify the Role of moisture content in food and also about the measurement of Turbidity and Humidity
2. Classify enzyme sensors, biosensors, Electronics Nose used in food manufacturing industries
3. Summarize the concepts of automatic controllers and Indicators used in food industry
4. Implement chromatography and mass spectrometry to the analysis of food products
5. Execute other Analytical Equipment like Scanning electron microscopy, Tandem Electron Microscopy

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	3		-	
2	2	1	3		-	
3	1	2	1		3	
4	2	1	2		1	3
5	1	1	2		2	1

9 Hours

UNIT I

MOISTURE, TURBIDITY AND HUMIDITY MEASUREMENTS

Role of moisture content in food - wet and dry method - IR technique. Humidity - Definitions - role in food processing - classical types - wet and dry bulb hygrometer - Electronic methods. Turbidity and colour: Definition and role, standards and units, basic turbidity meter, light scattering and absorbtion type

UNIT II **9 Hours**

FOOD ENZYMES AND FLAVOUR

Food enzymes and flavour : Human olfaction - Importance of enzyme sensors - biosensors -sensing arrays - Electronics Nose.

UNIT III **9 Hours**

CONTROLLERS AND INDICATORS

Basic control concept - Temperature controller in dryer - ration control in food pickling -atmospheric controller in food preservation.

UNIT IV **9 Hours**

CHROMATOGRAPHY AND MASS SPECTROMETRY IN FOOD INDUSTRY

Basics of gas and liquid chromatography - GC and HPLC Application in food analysis - MS application in food analysis

UNIT V **9 Hours**

OTHER ANALYTICAL EQUIPMENTS

Fourier transform Infra red spectroscopy, Scanning electron microscopy, Tandem Electron Microscopy

Total: 45 Hours

Reference(s)

1. Nielsen, S.S,-Introduction to the chemical analysis of foods- Jones and Bartlett Publishers, Boston, London 2004.
2. Mahindru,S.N, -Food additives. Characteristics, detection and estimation-. Tata Mc Graw-Hill Publishing Company Limited, New Delhi 2000.
3. B.G.Liptak, ed -Instrument Engineers Handbook: Process Measurement and Analysis-, Butterworth & Heineman, 1995
4. R G. Moreira, T.P Coultate Automatic Control for Food Processing System. 2001.
5. Willard, H.H., L. L. Merrit, J. A. Dean and F. L. Seattle, Instrumental Methods of Analysis, CBS Publishing Co, New York,2010

18IE55 ENVIRONMENTAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To introduce the role of instrumentation in environmental system.
- To enable the students to familiarise the environmental aspects of water quality, sedimentation and flotation process
- To enable the students to understand the causes of environmental pollutions, like water and air.

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the various techniques used for the measurement and control of environment parameters.
2. Identify the various methodologies in water quality assessment.
3. Differentiate the Sedimentation and flotation methods.
4. Analyze the Waste water and Flow Monitoring Systems
5. Compare Air pollution and sound Pollution systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	3		1	2
2	2	3	1		2	2
3	3	1	2		-	3
4	1	2	2		-	2
5	2	1	3		-	2

UNIT I **9 Hours**

INTRODUCTION INSTRUMENTATION

Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.

UNIT II **9 Hours**

QUALITY OF WATER

Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requirement of water treatment facilities, process design.

UNIT III **9 Hours**

SEDIMENTATION

General equation for settling or rising of discrete particles, hindered settling, effect of temperature, viscosity, efficiency of an ideal settling basin , reduction in efficiency due to various causes, sludge, storage & removal, design criteria of settling tank, effect of temperature on coagulation. Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution.

UNIT IV **9 Hours**

EQUIPMENTS FOR TREATMENT UNITS

Equipment for treatment unit - electrically and mechanically operated agitators, mixers, aerators, chlorinators, Surface aerators. Meters for measurement of flow, head, electricity.

UNIT V **9 Hours**

AIR POLLUTION CONTROL EQUIPMENTS

Working principles of electrostatic precipitator - cyclone separators - settling chamber - operation and Maintenance. Machinery for solid waste collection and disposal incineration - compactors - magnetic separators incinerators.

Total: 45 Hours

Reference(s)

1. Water treatment technology -Walter J. Weber.
2. Air pollution control technology - Wark & Warner.
3. Environmental Instrumentation & Analysis Handbook-Randy D. Down..
4. Environmental Instrumentation & Analysis Handbook, Randy D. Down & Jay H. Lehr, Wiley.

18IE56 AUTOMOBILE INSTRUMENTATION 3 0 0 3

Course Objectives

- To introduce the role of instrumentation in Automobile industries.
- To enable the students to familiarize the automobile aspects of ignition, injection and starting process
- To enable the students to understand the sensors and actuators

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the various techniques used for the measurement and control of environment parameters.
2. Identify the various methodologies in Starting process.
3. Differentiate the Ignition and Injection methods.
4. Analyze the Sensors and Actuators.
5. Compare Charging and Lighting systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1	3		2
2	2	3	2	1		3
3	2	3	-	2		1
4	2	1	3	1		2
5	2	3	1	2		-

UNIT I **9 Hours**

FUNDAMENTALS OF AUTOMOTIVE INSTRUMENTATION

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system

UNIT II **9 Hours**

BATTERIES AND STARTING SYSTEM

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches.

UNIT III **9 Hours**

INJECTION AND IGNITION SYSTEM

Heat release in the diesel engine and need for control of fuel injection. Inline injection pump - Rotary Pump and injector- Construction and principle of operation, Electronic control of these pumps - Common rail and unit injector system - Construction and principle of operation - Ignition fundamentals, solid state ignition systems, high energy ignition distributors, Electronic spark timing and control. Combined ignition and fuel management systems - Dwell angle calculation, Ignition timing calculation

UNIT IV **9 Hours**

SENSORS AND ACTUATORS

Introduction, basic sensor arrangement, Types of sensors such as oxygen sensors, Crank angle position sensors Fuel metering, vehicle speed sensor and detonation sensor Altitude sensor, flow sensor - Throttle position sensors, solenoids, stepper motors, relays, sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

UNIT V **9 Hours**

CHARGING SYSTEM AND LIGHTING

Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cut out - Voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects and bridge rectifiers, new developments. Lighting system: Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

Total: 45 Hours

Reference(s)

1. BOSCH Automotive Handbook 8th Edition, Bentley publishers, 2011
2. Allan Bonnick, Automotive Computer Controlled Systems 2011
3. Tom Weather Jr and Cland C.Hunter, Automotive Computers and Control system Prentice Hall Inc., New Jersey.
4. Young A. P & Griffiths L, Automobile Electrical and Electronic Equipments English Languages Book Society & New Press, 1990
5. Santini Al, Automotive Electricity and Electronics Cengage Learning, 2012.

18IE57 BUILDING AUTOMATION 3 0 0 3

Course Objectives

- To understand the basic concept of intelligent buildings and building automation systems.
- To understand the concept and design of BMS and fire alarm systems
- To impart a comprehensive knowledge on CCTV and HVAC systems

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document

Course Outcomes (COs)

1. Design & Development of building automation systems.
2. Develop skills to Execute Fire alarm and HVAC circuits.
3. Indicate Procedures, Guidelines and Thumb Rules for installing Closed Circuit Television System
4. Differentiate HVACs for cold and hot water system
5. Implement closed circuit for television system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2	2		
2	1	2	3	1		
3	2	1	3	2		
4	1	2	1	3		
5	2	1	2	1		

UNIT I **9 Hours**

INTRODUCTION TO INTELLIGENT BUILDINGS AND BUILDING AUTOMATION SYSTEMS

Intelligent architecture and structure-Facilities management vs. intelligent buildings-Lifecycle of building-Evolution of intelligent buildings- Different systems BAS: HVAC-security-fire- lighting-systems: Importance of each system in BAS.

UNIT II **9 Hours**

COMFORT PARAMETERS FOR HUMAN BEING AND MEASUREMENT IN BMS SYSTEM

Temperature, Heat, Specific Heat, Sensitive Heat & Latent Heat, Enthalpy, Entropy Heat Transfer Conduction, Convection, Radiation Working Principle, Characteristics of different types of temperature sensors RTD-Humidity: Specific Humidity-Relative Humidity-Due point

UNIT III **9 Hours**

FIRE ALARM DETECTION SYSTEM REQUIREMENT

Stages of Fire Alarm System, Component within Fire Alarm System, Specific Function within Component Within Fire alarm System, Important Codes-NFPA72 IS 2189 BS 5839-Critical Parameters in Facility Environment: FAS Loops-Classification of Loops and Examples, Power Supply Requirement and its designing parameters, Battery Calculations and Its Requirement and design

UNIT IV **9 Hours**

HVAC FOR COLD AND HOT WATER SYSTEM

Chilled Water Systems: Concept of refrigeration cycle-evaporator-condenser-compressor, expansion valve-cooling towers-heat pump- types of chillers systems-Hot water systems: Working and design of different types of boilers-fire tube-water tube, packaged Boiler-Control of boiler: 7 element control- fuel and air ratio control-heat exchanger

UNIT V **9 Hours**

CLOSED CIRCUIT TELEVISION SYSTEM

CCTV: Basic of CCTV system-System Architecture of CCTV System Types of Camera Fixed, PTZ-Analog and Digital Terminology for Camera CIF, Mpeg, MP4, POE Concepts of Camera Connectivity-Video Management System: DVR, DVM, NVR Video Analytics Camera Calculations Parameters Resolution, Compression, Image Connectivity.

Total: 45 Hours

Reference(s)

1. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs) (Hardcover) by Reinhold A. Carlson (Author), Robert A. Di Giandomenico (Author).
2. Building Automation: Control Devices and Applications by In Partnership with NJATC (2008).
3. Building Control Systems, Applications Guide (CIBSE Guide) by The CIBSE (2000).
4. Design of Special Hazards and Fire Alarm Systems by Robert Gagnon (2007).
5. Security/Fire Alarm Systems: Design, Installation, and Maintenance by John E. Traister (1995).
6. CCTV (Newnes) by Vlado Damjanovski (1999).

18IE58 OPTIMAL CONTROL SYSTEM 3 0 0 3

Course Objectives

- To impart knowledge about optimal control systems and its approach for formulation of the system
- To familiarize the characteristics of linear quadratic systems of optimal control
- To improve the skill in dynamic programming of various control system

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer state space equation and calculus of variations.
2. Formulate performance measures for optimal control problem.
3. Design optimal controller using linear quadratic regulator concepts.
4. Compute optimal control solution for discrete systems using dynamic programming.
5. Differentiate the relation between dynamic programming and PontryaginÃ¢??s minimum principle

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	1	2		3
2	3	1	2	3		1
3	2	2	3	1		2
4	2	3	1	2		1
5	3	1	2			2

UNIT I **9 Hours**

INTRODUCTION

Static optimization with and without constraints - Matrix properties and definitions - Quadratic forms and definiteness - state space form for continuous systems and discrete system. Calculus of variations: functionals of a single function, necessary and sufficient conditions: fixed initial and final boundary conditions

UNIT II **9 Hours**

OPTIMAL CONTROL FORMULATION

The Performance measure: performance measures for optimal control problems, selecting a performance measure, constraints - Variational approach to optimal control problems: necessary conditions for optimal control

UNIT III **9 Hours**

LINEAR QUADRATIC OPTIMAL CONTROL SYSTEMS

Problem formulation - Linear regulator problem - Infinite time linear quadratic regulator - meaningful interpretation of Riccati coefficient - analytical solution of algebraic Riccati equation - equivalence of open loop and closed loop. Design of LQR: inverted pendulum, DC motor speed control

UNIT IV **9 Hours**

DYNAMIC PROGRAMMING

The Optimal control law -Principle of optimality - dynamic programming applied to routing problem - an optimal control system -recurrence relation of dynamic programming - computational procedure for solving control problems- characteristics of dynamic programming solutions.

UNIT V **9 Hours**

PONTRYAGINS MINIMUM PRINCIPLE

Minimum time problems - relation between dynamic programming and the minimum principle - two point boundary value problems - quasi linearization

Total: 45 Hours

Reference(s)

1. Kirk, Donald E., "Optimal Control Theory: An Introduction", Dover publications, 2004.
2. Desineni Subburam Naidu, "Optimal Control Systems", CRC Press,2003
3. Zdzislaw Bubnicki, "Modern Control System", Springer,2005
4. Anderson B.D.O. and Moore J.B., "Optimal Control: Linear Quadratic Methods", Dover Publications, 2014.
5. I. Michael Ross., "A Primer on Pontryagin's Principle in Optimal Control", Collegiate Publishers, Second Edition, 2015

18IE59 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

3 0 0 3

Course Objectives

- To analyse the mathematical model of a system using non parametric, parametric and recursive identification methods.
- To get adequate knowledge about adaptive control methodology and its various schemes
- To design adaptive control scheme for real time systems and analyse its stability behavior

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Analyse the mathematical representation of a system using transient and frequency response methods
2. Analyse the mathematical representation of a system using regression, prediction and estimation methods
3. Analyse the mathematical representation of a system using recursive least square, direct and indirect methods
4. Interpret the concept of adaptive control and analyse its schemes
5. Apply Adaptive control concept to industrial processes and analyse the stability and robustness of the process

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3			2
2	2	1	3			2
3	2	2	1	3		1
4	2	2	2	1		3
5	2	1	3	2		1

UNIT I **6 Hours**

SYSTEM IDENTIFICATION USING NON PARAMETRIC METHODS

Non parametric methods: Transient analysis-frequency analysis-Correlation analysis- Spectral analysis.

UNIT II **10 Hours**

SYSTEM IDENTIFICATION USING PARAMETRIC METHODS

Linear Regression: The Lease square estimate-best liner unbiased estimation under linear constraints-updating the Parameter estimates for linear regression models-Prediction error methods: Description of Prediction error methods-Optimal Prediction - Instrumental variable methods: description of Instrumental variable methods

UNIT III **10 Hours**

RECURSIVE IDENTIFICATION METHODS

The recursive lest squares method-the recursive Instrument variable method-the recursive prediction error method-model validation and model structure determination. Identification of systems operating in closed loop: Direct identification- Indirect identification-joint input - output identification.

UNIT IV **10 Hours**

ADAPTIVE CONTROL SCHEMES

Introduction - users- Definitions-auto tuning-types of adaptive control-gain scheduling controller Model Reference Adaptive Control schemes - self tuning controller. MRAC and STC: Approaches - The Gradient approach - Lyapunov functions - Passivity theory - pole placement method Minimum variance control - Predictive control.

UNIT V **9 Hours**

APPLICATION OF ADAPTIVE CONTROL AND ANALYSIS

Application of adaptive control: Distillation column control, Continuous Stirred Tank Reactor Control. Analysis: Stability - Convergence - Robustness

Total: 45 Hours

Reference(s)

1. Soderstorm.T and Petre stioca, System Identification, Prentice Hall International (UK) Ltd. 1989.
2. Karl J.Astrom and Bjorn Wittenmark, Adaptive Conrol, Pearson Education, 2nd Editon, 2001.
3. Ljung,L.System Identification: Theory for the user, Pretice Hall, Englewood cliffs, 1987.
4. Sastry S. and Bodson M., Adaptive control stability, Convergence ad Robustness, Prentice Hall inc., New Jersey, 12989.

18IE60 DIGITAL CONTROL SYSTEM 3 0 0 3

Course Objectives

- To give basic knowledge in digital control system
- To impart necessary knowledge in stability analysis for discrete system
- To model systems in state space representation
- To provide a solution to state equations and to study various computational algorithms
- To know about the compensators in digital controllers.

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the concepts of digital control system
2. Analyze the stability of the discrete system
3. Identify the concepts of State Space System
4. Design a compensator for the given system.
5. Implement various compensation techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	1		2
2	3	3	1	2		2
3	3	1	2			3
4	1	2	-			1
5	2	1	-			2

UNIT I **9 Hours**

DIGITAL CONTROL SYSTEM

Digital control system - sample and hold - analog to digital converter - digital to analog converter - quantizing and quantizing error - sampling process - frequency response of zero order hold - first order hold - PI, PD controllers - digital PID

UNIT II **9 Hours**

RESPONSE OF DISCRETE SYSTEM

Pulse transfer function of cascaded elements, closed loop systems - characteristic equation - relationship between s-plane and z-plane poles - unit step response of digital control system -stability of discrete system - Jury's stability test - Root locus technique for digital system

UNIT III **9 Hours**

STATE SPACE REPRESENTATION

State variable formulation of discrete system - decomposition of discrete transfer function - direct decomposition - cascade decomposition and parallel decomposition -solution of state equation by recursive method - state transition matrix and its properties.

UNIT IV **9 Hours**

SOLUTION OF STATE EQUATION

Solution of discrete time state equation - evaluation of state transition matrix - transfer function matrix - Discretisation of continuous time system - Solution of discrete time state equation by Cayley Hamilton theorem

9 Hours

UNIT V

COMPENSATION TECHNIQUES

Compensation by continuous network - compensation by digital computer - frequency domain technique of designing D(z) FOR FURTHER READING Simulation of types of digital controller - Simulation of discrete system to analysis the stability - Simulation of discrete time state equation - Simulation of compensation techniques

Total: 45 Hours

Reference(s)

1. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2012
2. K. Ogata, Discrete time control system, Pearson Education Asia, New Delhi 2011
3. I.J. Nagarath and M. Gopal, Control System Engineering, New age International P.Ltd, New Delhi 2011 4. Lawrence J. Kamm, Understanding Electro Mechanical Engineering: An Introduction to Mechatronics, Prentice Hall of India Pvt., Ltd., 2000

18IE61 FAULT TOLERANT CONTROL 3 0 0 3

Course Objectives

- To familiarize the students for the fault detection and isolation of industrial processes and Systems, additionally to fault-tolerant control with a special emphasis to model based techniques (analytical redundancy)
- To review the basic concept of fault detection systems
- To understand the concept of fault diagnosis systems

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Design and implementation of fault tolerant controllers for industrial systems and processes
2. Design decision logic description using languages
3. Design fault propagation analysis
4. Design and implement fault-tolerant control systems
5. Detect and quantify and compensate stiction in Control valves.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	1			
2	2	3	2	1		2
3	2	2	3	2		1
4	1	2	3	1		2
5	1	3	1	2		2

UNIT I **9 Hours**

INTRODUCTION

Introduction - Types of faults and different tasks of Fault Diagnosis and Implementation - Different Approaches to FDD: Model free and Model based approaches-Introduction- Mathematical Representation of Faults and Disturbances: Additive and Multiplicative types - Residual Generation: Detection, Isolation, Computational and stability properties - Design of Residual generator - Residual specification and Implementation.

UNIT II **9 Hours**

DESIGN OF STRUCTURED RESIDUALS

Introduction- Residual structure of single fault Isolation: Structural and Canonical structures-Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts - Introduction to parity equation implementation of residual generator and alternative representation - Directional Specifications: Directional specification with and without disturbances - Parity Equation Implementation - Linearly dependent column.

UNIT III **9 Hours**

FAULT DIAGNOSIS USING STATE ESTIMATORS

Introduction - Review of State Estimators - Fault Detection and Diagnosis using Generalized Likelihood Ratio Approach and Marginalized Likelihood Ratio Approach

UNIT IV **9 Hours**

FAULT TOLERANT CONTROL

Introduction - Passive Fault-tolerant Control- Active Fault tolerant Control - Eigen structure assignment - Actuator and Sensor Fault tolerance Principles: - Compensation for actuator - Sensor Fault-tolerant Control Design - Fault-tolerant Control Architecture - Fault-tolerant Control design against major actuator failures.

UNIT V **9 Hours**

CASE STUDIES

Aircraft fault detection - Fault detection and diagnosis of DC Motor Drives - Fault detection and diagnosis of a Centrifugal pump pipe system - Fault tolerant Control of Three-tank System - Diagnosis and Fault-tolerant control of chemical process - supervision of steam generator - Different types of faults in Control valves - Automatic detection, quantification and compensation of valve stiction.

Total: 45 Hours

Reference(s)

1. Rolf Isermann, Fault-Diagnosis Systems: An Introduction from Fault Detection to Fault Tolerance Springer Verlag, 2011
2. Steven X. Ding, Model based Fault Diagnosis Techniques: Schemes, Algorithms, and Tools, Springer Publication, 2012
3. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, Fault- Tolerant Control Systems: Design and Practical Applications, Springer Publication, 2010
4. Mogens Blanke, Michel Kinnaert, Jan Lunze, Marcel Staroswiecki, Diagnosis and Fault- Tolerant Control, Springer, 2013
5. Prashant Mhaskar, Jinfeng Liu, Panagiotis D. Christofides , Fault-Tolerant Process Control: Methods and Applications, Springer, 2014
6. Ali Ahammad Shoukat Choudhury, Sirish L. Shah, Nina F. Thornhill, Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches, Springer Berlin Heidelberg, 2010

18IE62 DATA ANALYTICS 3 0 0 3

Course Objectives

- To impart basic knowledge on Big Data analytics.
- To understand various methods and algorithms to handle Big Data
- To familiarize students with Big Data management and visualization techniques

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the characteristics of Big Data.
2. Analyze and select suitable algorithms for Big Data Analytics.
3. Apply their knowledge in Data management and visualization processes of Big Data.
4. Differentiate graph memory and stream memory
5. Identify NOSQL data management for big data and visualization

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2			2
2	1	2	-			3
3	2	1	-			1
4	3	2	1			1
5	2	3	1		1	3

UNIT I **9 Hours**

INTRODUCTION TO BIG DATA

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Validating-The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big Data Applications - Perception and Quantification of Value -Understanding Big Data Storage.

UNIT II **9 Hours**

CLUSTERING AND CLASSIFICATION

Overview of Clustering - K-means - Use Cases - Overview of the Method - Determining the Number of Clusters - Diagnostics - Reasons to Choose and Cautions .- Classification: Decision Trees - Overview of a Decision Tree - General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree

UNIT III **9 Hours**

ASSOCIATION AND RECOMMENDATION SYSTEM

Association Rules - Overview - Apriority Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association& finding similarity - Collaborative Recommendation- Content Based Recommendation - Knowledge Based Recommendation

UNIT IV **9 Hours**

GRAPH MEMORY AND STREAM MEMORY

Graph Analytics - The Graph Model - Representation as Triples - Graphs and Network Organization - Choosing Graph Analytics - Graph Analytics Use Cases - Graph Analytics Algorithms and Solution Approaches - Introduction to Streams Concepts - Sampling Data in a Stream - Filtering Streams - Counting Distinct Elements in a Stream - Decaying Window - Real time Analytics Platform(RTAP) applications - Case Studies - Real Time Sentiment Analysis.

UNIT V **9 Hours**

NOSQL DATA MANAGEMENT FOR BIG DATA AND VISUALIZATION

NoSQL Databases : Schema-less Models: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases Hive - Sharding - Hbase - Analyzing big data with twitter - Big data for E-Commerce Big data for blogs - Review of Basic Data Analytic Methods using R

Total: 45 Hours

Reference(s)

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
3. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
4. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2015.
5. Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce",
6. Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010

18IE63 DEEP LEARNING 3 0 0 3

Course Objectives

- To impart basic knowledge on Deep Neural Networks.
- To understand various methods and algorithms of Deep Learning.
- To familiarize students with computer vision modules and Natural Language Processing.

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools

c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Interpret the advanced methods of machine learning.
2. Analyze and select suitable algorithms for Deep Learning.
3. Apply their knowledge in Deep Learning for computer vision modules and Natural Language Processing.
4. Apply deep learning technologies in computers
5. Apply deep learning to natural language processing

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3		2	1
2	2	2	1		1	2
3	2	3	2	1	2	2
4	3	2	2	2	2	2
5	1	2	3	1	3	1

UNIT I **9 Hours**

INTRODUCTION

Feed-forward Neural networks, Gradient descent and the back-propagation algorithm. Unit saturation, aka the vanishing gradient problem, and ways to mitigate it, RelU Heuristics for avoiding bad local minima, Heuristics for faster training, Nestors accelerated gradient descent, Regularization, Dropout.

UNIT II **8 Hours**

NEURAL NETWORKS

Architectures, convolution / pooling layers, LSTM, GRU, Encoder Decoder architectures

UNIT III **10 Hours**

DEEP UNSUPERVISED DEEP UNSUPERVISED LEARNING

Auto-encoders (standard, sparse, de-noising, contractive, etc), Variational auto-encoders, Adversarial Generative Networks, Auto-encoder and DBM

UNIT IV **9 Hours**

APPLICATIONS OF DEEP LEARNING TO COMPUTER

Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks

UNIT V **9 Hours**

APPLICATIONS OF DEEP LEARNING TO NATURAL LANGUAGE PROCESSING

Introduction to NLP and Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning.

Total: 45 Hours

Reference(s)

1. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book (2015).
2. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1 (2009): 1127.
3. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification. Wiley-Interscience. 2nd Edition. 2001.
4. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008.
5. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.

18IE64 INSTRUMENTATION IN PAPER AND PULP INDUSTRIES

3 0 0 3

Course Objectives

- To understand the various unit operations in the paper industry
- To find the alternative sensors and transducers for various measurements
- To evolve the appropriate controls and schematics for specific applications
- To know the world-class paper mills employing IT-enabled applications

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Recall the parts of instrumentation and their working in paper industry
2. Analyze the basic paper properties and its measurement
3. Examine the concepts of making paper in industry
4. Analyze the consistency measurement and control in paper industry
5. Implement the different control technique in paper industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	3	2	2		3
2	2	2	3	2		1
3	2	3	2	3		2
4	1	2	3	2		3
5	2	3	2	3		2

UNIT I **9 Hours**

AN OVERVIEW OF PAPER MAKING PROCESS

Paper making process-Raw materials -Pulp separation screening-Bleaching-Cooking-Chemical reactionchippers- types of digesters-H factor and Kappa factors-Stock preparation-Instrumentation needs Energy conservation and paper quality control

UNIT II **9 Hours**

PAPER PROPERTIES AND ITS MEASUREMENT

Physical, electrical, optical and chemical properties of paper-Basic weight, thickness, density, porosity, smoothness, softness, hardness and compressibility-stress -strain relationship-Tensile strength, bursting strength, tearing resistance, folding endurance, stiffness and impact strength -Dielectric constant, dielectric strength, dielectric loss and Properties of electrical insulating paper - Brightness, colour, gloss and capacity Starch constant acidity and pH-Measurement techniques

UNIT III **9 Hours**

CONSISTENCY MEASUREMENT

Definition of consistency-Techniques for head box consistency measurement - Stock consistency measurement and control

UNIT IV **9 Hours**

PAPER MAKING MACHINE

Functioning of Paper making machine-Quality parameters-moisture, basic weight, caliper, brightness, colour, ash content, strength, gloss and tensile strength - Parameters monitoring Instrumentation

UNIT V **9 Hours**

CONTROL ASPECTS

Machine and cross direction control technique -consistency, moisture -and basic weight control -dryer control-computer based control systems Mill wide control.

Total: 45 Hours

Reference(s)

1. Sankaranarayanan, P.E., Pulp and Paper Industries -Technology and Instrumentation Kotharis Desk book series, 1995
2. Handbook of Pulp and Paper technology, Britt K.W.Van Nostrand Reinbold Company, 1970
3. James P.Casey , Pulp and Paper chemistry and chemical Technology, John Wiley and sons, 1981
4. Austin G.T., Shrencs Chemical Process Industries, McGraw Hill International Student Edition, Singapore, 1985
5. B. Yagnanarayanan, Artificial Neural Networks, Prentice Hall of India Ltd .,New Delhi.2012.
6. G.J. Klir and T.A. Folger, Fuzzy Sets, Uncertainty and Information, Prentice-Hall of India Ltd., New Delhi, 2009.

18IE65 MACHINE LEARNING 3 0 0 3

Course Objectives

- Interpret the introductory concepts and techniques of Machine Learning and thorough understanding of the Supervised and Unsupervised learning techniques
- Summarize the various probability based learning techniques
- Develop a graphical models of machine learning algorithms

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Distinguish between, supervised, unsupervised and semi-supervised learning
2. Represent any apt linear models for any given problem
3. Implement the tree and probabilistic model for any given problem
4. Interpolate existing machine learning algorithms to improve classification efficiency
5. Design systems that use the appropriate graph models of machine learning

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3	2		1
2	2	3	2	2		2
3	3	2	1	1		3
4	2	3	1	2		2
5	1	2	3	2		2

UNIT I **9 Hours**

INTRODUCTION

Learning - Types of Machine Learning - Supervised Learning - The Brain and the Neuron - Design a Learning System - Perspectives and Issues in Machine Learning - Concept Learning Task - Concept Learning as Search - Finding a Maximally Specific Hypothesis - Version Spaces and the Candidate Elimination Algorithm - Linear Discriminants - Perceptron - Linear Separability - Linear Regression.

UNIT II **9 Hours**

LINEAR MODELS

Multi-layer Perceptron - Going Forwards - Going Backwards: Back Propagation Error - Multi-layer Perceptron in Practice - Examples of using the MLP - Overview - Deriving Back-Propagation - Radial Basis Functions and Splines - Concepts - RBF Network - Curse of Dimensionality - Interpolations and Basis Functions - Support Vector Machines

UNIT III **9 Hours**

TREE AND PROBABILISTIC MODELS

Learning with Trees - Decision Trees - Constructing Decision Trees - Classification and Regression Trees - Ensemble Learning - Boosting - Bagging - Different ways to Combine Classifiers - Probability and Learning - Data into Probabilities - Basic Statistics - Gaussian Mixture Models - Nearest Neighbor Methods - Unsupervised Learning - K means Algorithms - Vector Quantization - Self Organizing Feature Map

UNIT IV **9 Hours**

DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS

Dimensionality Reduction - Linear Discriminant Analysis - Principal Component Analysis - Factor Analysis - Independent Component Analysis - Locally Linear Embedding - Isomap - Least Squares Optimization - Evolutionary Learning - Genetic algorithms Ãƒ?Ã‚¢?? Genetic Offspring: - Genetic Operators - Using Genetic Algorithms - Reinforcement Learning - Overview - Getting Lost Example - Markov Decision Process

UNIT V **9 Hours**

GRAPHICAL MODELS

Markov Chain Monte Carlo Methods - Sampling - Proposal Distribution - Markov Chain Monte Carlo - Graphical Models - Bayesian Networks - Markov Random Fields - Hidden Markov Models - Tracking Methods

Total: 45 Hours

Reference(s)

1. Stephen Marsland, Machine Learning "An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014
2. Tom M Mitchell, "Machine Learning", First Edition, McGraw Hill Education, 2013
3. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012
4. Jason Bell, Machine learning "Hands on for Developers and Technical Professionals", First Edition, Wiley, 2014

18IE66 INTERNET OF THINGS 3 0 0 3

Course Objectives

- Interpret the introductory concepts, architecture and the real world design constraints of Internet of Things (IoT)
- Summarize the various protocol standards deployed in the Internet of Things (IoT) and their implementations
- Familiarize the students with python programming

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Compare the IoT with M2M by analyzing the characteristics and functional blocks of IoT
2. Examine the reference architectural models, physical devices, technologies and real world design constraints of IoT design
3. Explain the various protocols used in data link layer & network layer
4. Analyze the various communication protocols & standards used in transport, session & service layer
5. Apply python programming for IoT design

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	1	2		2	2
2	2	2	1		2	3
3	2	3	2		1	2
4	2	3	2		2	1
5	3	2	2		1	2

UNIT I **9 Hours**

INTRODUCTION TO INTERNET OF THINGS

IoT - Evolution of IoT - Main design principles, Requirements and Societal Impact of IoT, IoT Building Blocks - M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), and IoT Analytics - Embedded Systems in IoT and the interaction between software and hardware in an IoT device, Applications of IoT, Challenges in IoT.

UNIT II **9 Hours**

REFERENCE ARCHITECTURE

Iot architecture - State of the art - Introduction, Reference model and architecture, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints, Technical Design constraints, Data representation and visualization, Interaction and remote control.

UNIT III **7 Hours**

IOT DATA LINK LAYER

PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP.

UNIT IV **9 Hours**

TRANSPORT, SESSION LAYER, SERVICE LAYER PROTOCOLS

Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) - Session Layer - HTTP, CoAP, XMPP, AMQP, MQTT. Service Layer -oneM2M, ETSI M2M, OMA, BBF - Security in IoT Protocols - MAC 802.15.4, 6LoWPAN, RPL, Application Layer.

UNIT V **11 Hours**

DEVELOPING INTERNET OF THINGS

Introduction - IoT Design Methodology - Installing Python - Python Data Types & Data Structures - Control Flow - Functions, Modules & Packages - File Handling - Date/ Time Operations - Classes - Python Packages.

Total: 45 Hours

Reference(s)

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1 st Edition, Academic Press, 2014.

2. Peter Waher, Learning Internet of Things, PACKT publishing, Birmingham Mumbai, January 2015.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2011.
4. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, ISBN: 978-1-118- 47347-4, Willy Publications, July 2013.
5. Vijay Madisetti and ArshdeepBahga, Internet of Things (A Hands-on-Approach), 1 st Edition, VPT, 2014.
6. Adrian McEwen, Designing the Internet of Things, Wiley Publishers, 2013, ISBN: 978-1-118-43062-0

18IE67 ADVANCES IN SENSING TECHNIQUES 3 0 0 3

Course Objectives

- Tounderstand the advanced sensing methods.
- To familiarise the leading edge sensors research and design
- To understand the concept of Lab on chip

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Examine the features of sensing techniques and properties of sensing materials
2. Characterize different sensing techniques and apply for a given application.
3. Identify various characteristics and principles of chemical sensor
4. Design and model the sensors for various sensing applications
5. Infer all basic characteristics of designing sensor array

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	1		1	3
2	2	1	2		2	2
3	1	2	-		3	2
4	3	1	2		2	3
5	2	3	1		2	2

UNIT I **9 Hours**

INTRODUCTION

Importance of sensor/smart sensor in automation. Features of Advanced sensing techniques. Sensor classifications according to the energy domains. Introduction of advanced sensing materials. Properties (physical, electrical, chemical, biological) of materials which makes it suitable for sensing in different domain

UNIT II **9 Hours**

VARIOUS SENSING TECHNIQUES

Study of Tomography and Concept of Feed back in sensing Fabrication and packaging- Introduction to MEMS sensor. Comparison between MEMS and Macro sensor. Fabrication and packaging issue in sensor design. Thick film and thin film technique - Physical sensors -Hall Effect sensors, Eddy current sensors, magneto resistive and magneto strictive detectors, Accelerometers: Capacitive, Piezoelectric, Piezo resistive, Thermal Humidity and moisture sensor Proximity detectors using polarized light, Semiconductor gas sensor -Semiconductor gas sensor - Fluidic and Micro-fluidic sensors.

UNIT III **9 Hours**

CHEMICAL SENSOR

Chemical sensor characteristics, specific difficulties related to chemical sensor, Classification of Chemical sensing mechanism - Study of chemical sensor based on the principle direct sensing techniques such as Metaloxide chemical sensor, electro-chemical sensors, potentiometric sensors, conductive sensors, amperemetric sensors, enhanced catalytic gas sensors, enzyme sensors - Study of chemical sensors in indirect mode such as thermal sensor, optical chemical sensor, biochemical sensor, enzyme sensor.

UNIT IV **9 Hours**

DESIGN AND MODELLING

Design and modelling issue in advanced sensing technique - Introduction of different mathematical tools used in sensor design - Study of analytical design from given specification, conformal mapping - Optimization techniques used in sensor design. Numerical design such as FEM, FDM, etc.

UNIT V **9 Hours**

SENSOR ARRAY

Introduction to the concept of Lab on chip/senor platform technology - Therole of PCA, LDA, Neural network in designing sensor array - Study of temperature cycle mode of sensing to obtain virtual sensor array - Case study of a gas sensing platform, liquid sensing

Total: 45 Hours

Reference(s)

1. Feng Zhao, Leonidas Guibas, Jie Liu, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann,2016
2. Alberto Escarpa, "Sensors and Lab-on-a-Chip",Springer,2014
3. Tai-Ran Hsu, "MEMS and Micro Systems: Design and Manufacture and Nanosclae Engineering", TMH Publishers, 2008
4. R. Edwin Oosterbroek and Albert van den Berg, "Lab-on-a-Chip", Elsevier,2003
5. M J Usher, Sensors and Transducers, MacMillan ,1985

18IE68 ROBOTICS AND AUTOMATION 3 0 0 3

Course Objectives

- To know about the origin and types of robotics and its stabilization
- To develop a clear idea about hydraulic, pneumatic and electric drives
- To develop an optimal knowledge about machine interface in applications

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
e. expertise in the field of Industrial Automation
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Identify the history of industrial robots and the anatomy, features and applications of a typical robot
2. Interpret the actuator, sensor, control scheme and gripper of a typical robot application.
3. Apply homogenous transformation to obtain the forward and inverse kinematics of simple robot manipulators
4. Differentiate Kinematics And Path Planning
5. Apply Robotics concepts in various industries

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	3		1	2
2	2	3	2		2	2
3	3	2	1		2	1
4	-	1	2		3	2
5	1	2	1		2	2

UNIT I **9 Hours**

BASIC CONCEPTS

Brief history - types of robot -robot classifications and specifications - design and control issues- various manipulators - sensors - work cell - programming languages

UNIT II **9 Hours**

ACTUATORS AND SENSORS

Hydraulic, pneumatic and electric drives - determination of HP of motor and gearing ratio - servo motor - variable speed arrangements - machine vision - ranging sensors: acoustic, magnetic, eddy current type - laser and fiber optic sensor - tactile sensors

UNIT III **9 Hours**

GRIPPERS AND MATHEMATICAL REPRESENTATION OF ROBOT

Various types of grippers - design considerations of grippers - end effectors - mathematical representation of Robots - Position and orientation

UNIT IV **9 Hours**

KINEMATICS AND PATH PLANNING

Homogeneous transformation - various joints - representation using the Denavit Hattenberg parameters - degrees of freedom - direct kinematics - inverse kinematics

UNIT V **9 Hours**

CASE STUDIES

PID control scheme - selection of a robot - robots in manufacturing and non-manufacturing application - PUMA 560 & SCARA robots

Total: 45 Hours

Reference(s)

1. R. K. Mittal, I. J. Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 2012
2. R.D. Klafter, T.A. Chimielewski, M. Negin, Robotic Engineering : An integrated approach, Prentice Hall of India New Delhi, 2011
3. John J. Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2010
4. S.R. Deb, Robotics technology and flexible Automation, Tata McGraw Hill, 2011
5. P.J .Mc Kerrow , Introduction to Robotics, Addison Wesley, USA, 2011

18IE69 MICRO ELECTRO MECHANICAL SYSTEM 3 0 0 3

Course Objectives

- To acquire knowledge about various fabrication process, electrical and mechanical concepts in MEMS
- To impart a good knowledge about various MEMS sensors and actuators
- To understand applications of polymer and optical MEMS

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the concepts of fabrication methods and materials used in MEMS
2. Identify the application of MEMS in sensing and actuating process

3. Apply the sensing and actuators for different process
4. Use the etching types for micromachining process
5. Apply the polymer and optical MEMS in various measurements

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	2	2	2	1		2
2	2	2	1			1
3	3	1	2			3
4	2	3	1	2		2
5	2	3	1			2

UNIT I **9 Hours**

INTRODUCTION

Intrinsic Characteristics of MEMS - Energy Domains and Transducers - Sensors and Actuators - Introduction to Microfabrication - Silicon based MEMS processes - New Materials - Review of Electrical and Mechanical concepts in MEMS - Stress and strain analysis - Flexural beam bending - Torsional deflection

UNIT II **9 Hours**

SENSORS AND ACTUATORS-I

Electrostatic sensors - Parallel plate capacitors - Applications - Interdigitated Finger capacitor - Comb drive devices - Thermal Sensing and Actuation - Thermal expansion - Thermal couples - Thermal resistors - Applications - Magnetic Actuators - Micromagnetic components

UNIT III **9 Hours**

SENSORS AND ACTUATORS-II

Piezoresistive sensors - Piezoresistive sensor materials - Stress analysis of mechanical elements - Applications to Inertia, Pressure, Tactile and Flow sensors. Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials - Applications to Inertia, Acoustic, Tactile and Flow sensors

UNIT IV **9 Hours**

MICROMACHINING

Silicon anisotropic etching - Anisotrophic wet etching - Dry etching of silicon - Plasma etching Deep Reaction Ion Etching (DRIE) - Isotropic wet etching - Gas phase etchants - Case studies: Basic surface micromachining processes - Structural and sacrificial materials - Acceleration of sacrificial etch - Striction and antistriction methods

UNIT V **9 Hours**

POLYMER AND OPTICAL MEMS

Polymers in MEMS - Polyimide - SU-8 - Liquid Crystal Polymer (LCP) - PDMS - PMMA - Parylene - Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors - Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS

Total: 45 Hours

Reference(s)

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2014
2. Tai Ran Hsu, MEMS & Micro systems: Design, Manufacture and Nanoscale Engineering, Tata McGraw Hill, New Delhi, 2011
3. Julian W. Gardner, Vijay K. Varadan and Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & son Ltd, 2012

18IE70 POWER PLANT INSTRUMENTATION 3 0 0 3

Course Objectives

- To gain knowledge on the operation of various conventional power plants & also on the different types of controls being used in boilers
- To acquire knowledge in solar radiation measurements, Solar Photovoltaic systems and applications of solar energy
- To extend the views in the analysis of Geothermal resources, Ocean Energy and additional alternate energy resources

Programme Outcomes (POs)

a. carry out research /investigation and development activities to solve real time challenges
b. demonstrate capability to design and development of instrumentation systems using modern engineering tools
c. analyse the information required for developing the control schemes for linear and non linear system
d. write and present a substantial technical report/document
f. update the state of art techniques to enhance lifelong learning in the domain of Instrumentation

Course Outcomes (COs)

1. Infer the basic power generation methods in thermal, hydro and nuclear power plant
2. Interpret the solar energy sources
3. Select the instrumentation system used for wind energy systems and geothermal energy systems
4. Design control loops for power plants and
5. Identify various additional alternate energy sources

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	1	2		1
2	2	3	2	1		2
3	2	2	3	2		1
4	1	2	3	1		2
5	2	3	1	2		-

UNIT I **8 Hours**

OVERVIEW OF CONVENTIONAL POWER GENERATION AND CONTROL LOOPS IN BOILER

Brief survey of methods of power generation-Thermal Power plant, Hydro-Electric Power plant, Nuclear Power plant and Cogeneration -Control system diagramming - P&I diagram of boiler -Control loops in boiler - Combustion control -Measurement of furnace draft -Drum level control - Main steam and reheat steam temperature control -Deaerator - Combustion air flow control.

UNIT II **10 Hours**

SOLAR ENERGY

Solar radiation-Solar radiation measurements, Estimation of average solar radiation, Solar radiation on tilted surfaces -Solar energy collectors -Solar Photovoltaic systems -Solar cell characteristics, Solar cell Classification, Construction of PV module, panel and array, MPPT, Classification of PV systems - Applications of solar energy - Solar water heaters, Solar thermal electric conversion, Solar PV power generation, Solar cooking.

UNIT III **10 Hours**

WIND AND BIOMASS ENERGY

Wind Energy -Origin of winds, Nature of winds, Site selection considerations, Wind turbine aerodynamics, Basic components of a Wind Energy Conversion System, Wind turbine types and their construction, Design consideration of horizontal axis type wind turbine, Schemes for electrical energy generation (CSCF, VSCF, VSVF), Environmental aspects. Biomass Energy -Biomass resources, Biomass conversion technologies, Biomass gasification, Constant pressure type and constant volume type biogas plants.

UNIT IV **8 Hours**

GEOTHERMAL AND OCEAN ENERGY

Geothermal Energy-Types of Geothermal resources, Analysis of geothermal resources, Environmental consideration. Ocean Energy -Tidal Energy -Conversion scheme, Estimation of power -Wave Energy - Power in waves, Wave energy technology, Ocean Thermal Energy Conversion (OTEC) schemes -Claude cycle, Anderson cycle, Hybrid cycle, Environmental impacts.

UNIT V **9 Hours**

ADDITIONAL ALTERNATE ENERGY RESOURCES

Magneto Hydro Dynamic (MHD) power generation -Principles, MHD systems, Voltage and Power output of MHD generator, Materials for MHD generator. Thermoelectric power generation -Basic principles, thermoelectric power generator and its performance analysis, Selection of materials. Thermionic power generation -Principle, Thermionic generator and its performance analysis

Total: 45 Hours

Reference(s)

1. G.D.Rai, Non-Conventional Energy Resources, 5th Edition, Khanna Publishers, 2011
2. B.H. Khan, Non-Conventional Energy Resources, 11th Edition, Tata McGraw Hill, New Delhi, 2012
3. G.F. Gilman, Boiler Control Systems Engineering, 2nd Edition , ISA Publication, 2010
4. Larry Drbal, Power Plant Engineering, Kluwer academic publications, 2011