UNIVERSITY VISION AND MISSION

VISION

B.S. Abdur Rahman Institute of Science & Technology aspires to be a leader in Education, Training and Research in Engineering, Science, Technology and Management and to play a vital role in the Socio-Economic progress of the Country.

MISSION

- To blossom into an internationally renowned University.
- To empower the youth through quality education and to provide professional leadership.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

VISION AND MISSION OF THE DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

VISION

The Department aspires to excel in, providing quality education, training and research in the area of Electronics and Instrumentation Engineering to meet the industrial and societal needs

MISSION

- To provide quality education in the field of Electronics and Instrumentation Engineering by offering Under Graduate, Post Graduate and Doctoral Programs.
- To impart technical knowledge and hands on experience, leadership and managerial skills to meet the current industrial and societal needs.
- To enhance problem solving capabilities through design projects, internship and industrial projects.
- To maintain active linkages with industries and research institutions.
- To develop analytical skills, leadership quality and team spirit through balanced curriculum and a judicial mix of co-curricular, extra-curricular and professional society activities.
- To enrich the knowledge and skills of faculty through continuous learning and active research.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES
M.Tech (Electronics and Instrumentation Engineering)

PROGRAMME EDUCATIONAL OBJECTIVES

- Students will acquire advanced knowledge in Electronics & Instrumentation to face the needs of the Electronics & Instrumentation Industry.
- Students will develop the analytical and software skill to design and develop necessary instrumentation and control system for industrial automation.
- To impart knowledge in different types of advanced control systems
- To provide hands on experience in Industries through in-plant training.
- Students will develop team spirit, problem solving skill, and appreciation for ethical and social relevance of the technology used.
- To acquire research and communication skill through project in the relevant field of specialisation.

PROGRAMME OUTCOMES

On completion of the programme the graduates will

- have the capability for a carrier in industry, teaching and research.
- possess the necessary competence to formulate automation solutions for process industries.
- have the expertise to design and implement control systems to meet varied applications.
- have the ability to analyse and solve industrial problems, and execute research projects.
- have the competency to develop necessary model, simulate and implement solutions relating to control system engineering.
- have the skill in interfacing appropriate hardware and software for control systems.
- have the ability to discharge professional, social & economic responsibilities ethically.

B.S.ABDUR RAHMAN
UNIVERSITY
B.S. ABDUR RAHMAN INSTITUTE OF SCIENCE & TECHNOLOGY
(Estd.u/s 3 of the UGC Act, 1956)
(FORMERLY B.S.ABDUR RAHMAN CRESCENT ENGINEERING COLLEGE)
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048.

REGULATIONS 2013
FOR
M.TECH / MCA / M.Sc. DEGREE PROGRAMMES

(WITH AMENDMENTS INCORPORATED TILL JUNE 2015)

B.S. ABDUR RAHMAN UNIVERSITY, CHENNAI 48.
REGULATIONS -2013 FOR M.TECH / MCA / M.Sc. DEGREE PROGRAMMES

(With amendments incorporated till June 2015)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i) **"Programme"** means Post Graduate Degree Programme (M.Tech./ MCA / M.Sc.)

ii) **"Course"** means a theory or practical subject that is normally studied in a semester, like Applied Mathematics, Structural Dynamics, Computer Aided Design, etc.

iii) **"University"** means B.S.Abdur Rahman University, Chennai, 600048.

iv) **"Institution"** unless otherwise specifically mentioned as an autonomous or off campus institution means B.S.Abdur Rahman University.

v) **"Academic Council"** means the Academic Council of this University.

vi) **"Dean (Academic Affairs)"** means Dean (Academic Affairs) of B.S.Abdur Rahman University.

vii) **"Dean (Student Affairs)"** means Dean(Student Affairs) of B.S.Abdur Rahman University.

viii) **"Controller of Examinations"** means the Controller of Examinations of B.S.Abdur Rahman University who is responsible for conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

2.1 P.G. Programmes Offered

The various P.G. Programmes and their modes of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
M.Tech.	Part Time – Day / Evening
M.C.A.	Full Time
M. Sc.	Full Time
M. Sc.	Full Time

2.2 MODES OF STUDY

2.2.1 Full-time

Students admitted under "Full-Time" shall be available in the Institution during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

2.2.2 A full time student, who has completed all non-project courses desiring to do the Projectwork in part-time mode for valid reasons, shall apply to the Dean (Academic Affairs) through the Head of the Department, if the student satisfies the clause 2.3.4 of this Regulation. Permission may be granted based on merits of the case. Such conversion is not permitted in the middle of a semester.

2.2.3 Part time - Day time

In this mode of study, the students are required to attend classes for the courses registered along with full time students.

2.2.4 Part time - Evening

In this mode of study, the students are required to attend normally classes in the evening and on Saturdays, if necessary.

2.2.5 A part time student is not permitted to convert to full time mode of study.

2.3 ADMISSION REQUIREMENTS

2.3.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination of this University as specified in the Table shown for eligible entry qualifications for admission to P.G. programmes or any other degree examination of any University or authority accepted by this University as equivalent thereto.

2.3.2 Eligibility conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by this Institution from time to time.

2.3.3 All part-time students should satisfy other conditions regarding experience, sponsorship etc., which may be prescribed by this Institution from time to time.

2.3.4 A student eligible for admission to M.Tech. Part Time / Day Time programme shall have his/her permanent place of work within a distance of 65km from the campus of this Institution.

2.3.5 Student eligible for admission to M.C.A under lateral entry scheme shall be required to have passed three year degree in B.Sc (Computer Science) / B.C.A / B.Sc (Information Technology)

3.0 DURATION AND STRUCTURE OF THE P.G. PROGRAMME

3.1 The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min.No.of Semesters	Max.No.of Semesters
M.Tech. (Full Time)	4	8
M.Tech.(Part Time)	6	12
M.C.A. (Full Time)	6	12
M.C.A. (Full Time) – (Lateral Entry)	4	8
M.Sc. (Full Time)	4	8

3.2 The PG. programmes consist of the following components as prescribed in the respective curriculum

i. Core courses
ii. Elective courses
iii. Project work / thesis / dissertation
iv. Laboratory Courses
v. Case studies
vi. Seminars
vii. Industrial Internship

3.3 The curriculum and syllabi of all PG. programmes shall be approved by the Academic Council of this University.

3.4 The minimum number of credits to be earned for the successful completion of the programme shall be specified in the curriculum of the respective specialization of the P.G. programme.

3.5 Each academic semester shall normally comprise of 80 working days. Semester-end examinations will follow immediately after the last working day.

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
01.	Civil Engineering	M.Tech. (Structural Engineering)	B.E / B.Tech. (Civil Engineering) / (Structural Engineering)
		M.Tech. (Construction Engineering and Project Management)	
02.	Mechanical Engineering	M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Auto / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace /Aeronautical / Material Science / Marine Engineering)
		M.Tech. CAD / CAM	
03.	Polymer Engineering	M.Tech. (Polymer Technology)	B.E./ B.Tech. degree Mech./Production/ Polymer Science or Engg or Tech / Rubber Tech / M.Sc (Polymer Sc./ Chemistry Appl. Chemistry)
04.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engg)	B.E / B.Tech (EEE / ECE / E&I / I&C / Electronics / Instrumentation)
		M.Tech. (Power Electronics & Drives)	
05.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	B.E / B.Tech (EEE/ ECE / E&I / I&C / Electronics / Instrumentation)
		M.Tech.(VLSI and Embedded Systems)	B.E./ B.Tech. in ECE / Electronics / EIE / ICE / EEE
		M.Tech.(Signal Processing)	
06.	ECE Department jointly with Physics Dept	M.Tech. (Optoelectronics and Laser Technology)	B.E./B.Tech. (ECE / EEE / Electronics / EIE / ICE) M.Sc (Physics / Materials Science / Electronics / Photonics)
07.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation Engineering)	B.E./ B.Tech. (EIE/ICE/Electronics/ECE/ EEE)
08.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics) MCA
		M.Tech. (Software Engineering)	B.E. / B.Tech. (CSE / IT) MCA
		M.Tech (Network Security)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics) MCA
		M.Tech (Computer and Predictive Analytics)	
		M.Tech. (Computer Science and Engineering with specialization in Big Data Analytics)	
09	Information Technology	M.Tech. (Information Technology)	B.E /B.Tech. (IT/CSE/ECE/EEE/EIE/ICE/ Electronics) MCA
		M.Tech. (Information Security & Digital Forensics)	

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
10	Computer Applications	M.C.A.	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		M.C.A. (Full Time) – (Lateral Entry)	B.Sc Computer Science / B.Sc Information Technology / B.C.A
		M.Tech. (Systems Engineering and Operations Research)	BE / B.Tech. (Any Branch) or M.Sc., (Maths / Physics / Statistics / CS / IT / SE) or M.C.A.
		M.Tech. (Data & Storage Management)	
11	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the Subjects of Study.
		M.Sc. Mathematics	B.Sc. (Mathematics)
12	Physics	M.Sc.(Physics)	B.Sc.(Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
		M.Sc. (Material Science)	
13	Chemistry	M.Sc.(Chemistry)	B.Sc (Chemistry) of B.Sc. (Applied Science)
14	Life Sciences	M.Sc. Molecular Biology & Biochemistry	B.Sc. in any branch of Life Sciences
		M.Sc. Genetics	B.Sc. in any branch of Life Sciences
		M.Sc. Biotechnology	B.Sc. in any branch of Life Sciences
		M.Sc. Microbiology	B.Sc. in any branch of Life Sciences
		M.Sc. Bioscience	B.Sc. in any branch of Life Sciences
		M.Tech. Biotechnology	B.Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences

3.6 The curriculum of PG programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Minimum prescribed credit range
M.Tech.	75 to 85
M.C.A.	120 to 130
M.Sc.	75 to 85

3.7 Credits will be assigned to the courses for all P.G. programmes as given below:

* One credit for one lecture period per week
* One credit for one tutorial period per week
* One credit each for seminar/practical session/project of two or three periods per week
* One credit for two weeks of industrial internship.

3.8 The number of credits registered by a student in non-project semester and project semester should be within the range specified below:

P.G. Programme	Non-project Semester	Project semester
M.Tech. (Full Time)	15 to 29	12 to 20
M.Tech. (Part Time)	6 to 18	12 to 16
M.C.A. (Full Time)	15 to 29	12 to 20
M.Sc. (Full Time)	15 to 25	12 to 20

3.9 The electives from the curriculum are to be chosen with the approval of the Head of the Department.

3.10 A student may be permitted by the Head of the Department to choose electives offered from other PG programmes either within the Department or from other Departments up to a maximum of three courses during the period of his/her study, provided the Heads of the Departments offering such courses also agree.

3.11 To help the students to take up special research areas in their project work and to enable the department to introduce courses in latest/emerging areas in the curriculum, "Special Electives" may be offered. A student may be permitted to register for a "Special Elective" up to a maximum of three credits during the period of his/her study, provided the syllabus of this course is recommended by the Head of the Department and approved by the Chairman, Academic Council before the commencement of the semester, in which the special elective course is offered. Subsequently, such course shall be ratified by the Board of Studies and Academic Council.

3.12 The medium of instruction, examination, seminar and project/thesis/ dissertation reports will be English.

3.13 Industrial internship, if specified in the curriculum shall be of not less than two weeks duration and shall be organized by the Head of the Department.

3.14 PROJECT WORK/THESIS/DISSERTATION

3.14.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department.

3.14.2 A student may however, in certain cases, be permitted to work for the project in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization and the student shall be instructed to meet the faculty periodically and to attend the review committee meetings for evaluating the progress.

3.14.3 Project work / Thesis / Dissertation (Phase - II in the case of M.Tech.) shall be pursued for a minimum of 16 weeks during the final semester, following the preliminary work carried out in Phase-1 during the previous semester.

3.14.4 The Project Report/Thesis / Dissertation report / Drawings prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

3.14.5 The deadline for submission of final Project Report / Thesis / Dissertation is within 30 calendar days from the last working day of the semester in which Project / Thesis / Dissertation is done.

3.14.6 If a student fails to submit the Project Report / Thesis / Dissertation on or before the specified deadline he / she is deemed to have not completed the Project Work / Thesis / dissertation and shall re-register the same in a subsequent semester.

3.14.7 A student who has acquired the minimum number of total credits prescribed in the Curriculum for the award of Masters Degree will not be permitted to enroll for more courses to improve his/her cumulative grade point average (CGPA).

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member will be nominated by the HOD as Class Advisor for the whole class.

He/she is responsible for maintaining the academic, curricular and co-curricular records of all students throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling on the academic programme, the Head of the Department of the students will attach a certain number of students to a faculty member of the department who shall function as Faculty Advisor for the students throughout their period of study. Such Faculty Advisor shall offer advice to the students on academic and personal matters, and guide the students in taking up courses for registration and enrolment every semester.

5.0 CLASS COMMITTEE

5.1 Every class of the PG Programme will have a Class Committee constituted by the Head of the Department as follows:

i. Teachers of all courses of the programme

ii. One senior faculty preferably not offering courses for the class, as Chairperson.

iii. Minimum two students of the class, nominated by the Head of the Department.

iv. Class Advisor / Faculty Advisor of the class - Ex-Officio Member

v. Professor in-charge of the PG Programme - Ex-Officio Member.

5.2 The Class Committee shall be constituted by the respective Head of the Department of the students.

5.3 The basic responsibilities of the Class Committee are to review periodically the progress of the classes to discuss problems concerning curriculum and syllabi and the conduct of classes. The type of assessment for the course will be decided by the teacher in consultation with the Class Committee and will be announced to the students at the beginning of the semester. Each Class Committee will communicate its recommendations to the Head of the Department and Dean (Academic Affairs). The class committee, without the student members, will also be responsible for finalization of the semester results and award of grades.

5.4 The Class Committee is required to meet at least thrice in a semester, first within a week of the commencement of the semester, second, after the first assessment and the third, after the semester-end examination to finalize the grades.

6.0 COURSE COMMITTEE

Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers teaching the common course with one of them nominated as Course coordinator. The nomination of the Course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The Course Committee shall meet as often as possible and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the Course Committee may also prepare a common question paper for the test(s).

7.0 REGISTRATION AND ENROLMENT

7.1 For the first semester every student has to register and enroll for all the courses.

7.2 For the subsequent semesters registration for the courses will be done by the student during a specified week before the semester-end examination of the previous semester. The curriculum gives details of the core and elective courses, project and seminar to be taken in different semester with the number of credits. The student should consult his/her Faculty Adviser for the choice of courses. The Registration form shall be filled in and signed by the student and the Faculty Adviser.

7.3 From the second semester onwards all students shall pay the prescribed fees and enroll on a specified day at the beginning of a semester.

7.4 A student will become eligible for enrolment only if he/she satisfies clause 9 and in addition he/she is not debarred from enrolment by a disciplinary action of the Institution. At the time of enrolment a student can drop a course registered earlier and also substitute it by another course for valid reasons with the consent of the Faculty Adviser. Late enrolment will be permitted on payment of a prescribed fine up to two weeks from the date of commencement of the semester.

7.5 Withdrawal from a course registered is permitted up to one week from the date of the completion of the first assessment test.

7.6 Change of a course within a period of 15 days from the commencement of the course, with the approval of Dean (Academic Affairs), on the recommendation of the HOD, is permitted.

7.7 Courses withdrawn will have to be taken when they are offered next if they belong to the list of core courses.

7.8 A student should have registered for all preceding semesters before registering for a particular semester.

8.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

A student may be permitted by the Dean (Academic Affairs) to avail temporary break of study from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. Such student has to rejoin only in the same semester from where he left. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / THESIS / DISSERTATION

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum No. of credits to be earned to enroll for project semester
M.Tech. (Full time)	18 (III semester)
M.Tech. (Part time)	18 (V semester)
M.C.A. (Full time)	45 (V semester)
M.C.A. (Full time) – (Lateral Entry)	22 (V semester)
M.Sc.(Full time)	30 (IV semester) if project is in IV semester
	18 (III semester) if project is in III semester

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 DISCIPLINE

10.1 Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which will tend to bring down the prestige of the Institution.

10.2 Any act of indiscipline of a student reported to the Head of the Institution will be referred to a Discipline and Welfare Committee for taking appropriate action.

10.3 Every student should have been certified by the HOD that his / her conduct and discipline have been satisfactory.

11.0 ATTENDANCE

11.1 Attendance rules for all Full Time Programme and Part time - day Time Programmes are given in the following sub-clause.

11.2 Ideally every student is expected to attend all classes and earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% for genuine reasons like on medical grounds, representing the University in approved events etc., to become eligible to appear for the semester-end examination in that course, failing which the student shall be awarded "I" grade in that course. If the course is a core course, the student should register for and repeat the course when it is offered next. If the course is an elective, either he/she can register and repeat the same elective or can register for a new elective.

11.3 The students who have not attended a single hour in all courses in a semester and awarded 'I' grade are not permitted to write the examination and also not permitted move to next higher semester. Such students should repeat all the courses of the semester in the next Academic year.

12.0 SUMMER TERM COURSES

12.1 Summer term courses may be offered by a department on the recommendation of the Departmental Consultative Committee and approved by the Dean (Academic Affairs). No student should register for more than three courses during a summer term.

12.2 Summer term courses will be announced by the Head of the department at the end of the even semester before the commencement of the end semester examinations. A student will have to register within the time stipulated in the announcement. A student has to pay the fees as stipulated in the announcement.

12.3 The number of contact hours and the assessment procedure for any course during summer term will be the same as those during regular semesters.

Students with U grades will have the option either to write semester end arrears exam or to redo the courses during summer / regular semesters, if they wish to improve their continuous assessment marks subject to the approval of the Head of the department.

12.4 Withdrawal from a summer term course is not permitted. No substitute examination will be conducted for the summer term courses.

13.0 ASSESSMENTS AND EXAMINATIONS

13.1 The following rule shall apply to the full-time and part-time PG programmes (M.Tech./ M.C.A. / M.Sc.)

For lecture-based courses, normally a minimum of two assessments will be made during the semester. The assessments may be combination of tests and assignments. The assessment procedure as decided in the Class Committee will be announced to the students right from the beginning of the semester by the course teacher.

13.2 There shall be one examination of three hours duration, at the end of the semester, in each lecture based course.

13.3 The evaluation of the Project work will be based on the project report and a Viva-Voce Examination by a team consisting of the supervisor concerned, an Internal Examiner and External Examiner to be appointed by the Controller of Examinations.

13.4 At the end of industrial internship, the student shall submit a certificate from the organization and also a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a Departmental Committee constituted by the Head of the Department.

14.0 WEIGHTAGES

14.1 The following shall be the weightages for different courses:

(i) Lecture based course

Two continuous assessments	- 50%
Semester-end examination	- 50%

(ii) Laboratory based courses

Laboratory work assessment	- 75%
Semester-end examination	- 25%

(iii) Project work

Periodic reviews	- 50%
Evaluation of Project Report by External Examiner	- 20%
Viva-Voce Examination	- 30%

14.2 Appearing for semester end examination for each course (Theory and Practical) is mandatory and a student should secure a minimum of 40% marks in semester end examination for the successful completion of the course.

14.3 The markings for all tests, tutorial, assignments (if any), laboratory work and examinations will be on absolute basis. The final percentage of marks is calculated in each course as per the weightages given in clause 13.1.

15.0 SUBSTITUTE EXAMINATION

15.1 A student who has missed for genuine reasons any one of the three assessments including semester-end examination of a course may be permitted to write a substitute examination. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accident or admissions to a hospital due to illness, etc.

15.2 A student who misses any assessment in a course shall apply in a prescribed form to the Dean (Academic Affairs) through the Head of the department within a week from the date of missed assessment. However the substitute tests and examination for a course will be conducted within two weeks after the last day of the semester-end examinations.

16.0 COURSEWISE GRADING OF STUDENTS AND LETTER GRADES

16.1 Based on the semester performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and the corresponding grade points are as follows, but grading has to be relative grading

Letter grade	Grade points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-
I	-
AB	-

Flexible range grading system will be adopted

“W” denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevention from semester-end examination

"U" denotes unsuccessful performance in a course.

“AB” denotes absent for the semester end examination

16.2 A student is considered to have completed a course successfully if he / she secure five grade points or higher. A letter grade ‘U’ in any course implies unsuccessful performance in that course.

16.3 A course successfully completed cannot be repeated for any reason.

17.0 AWARD OF LETTER GRADE

17.1 A final meeting of the Class Committee without the student member(s) will be convened within ten days after the last day of the semester end examination. The letter grades to be awarded to the students for different courses will be finalized at the meeting.

17.2 After finalization of the grades at the class committee meeting the Chairman will forward the results to the Controller of Examinations, with copies to Head of the Department and Dean (Academic Affairs).

18.0 DECLARATION OF RESULTS

18.1 After finalization by the Class Committee as per clause 16.1 the Letter grades awarded to the students in the each course shall be announced on the departmental notice board after duly approved by the Controller of Examinations.

18.2 In case any student feels aggrieved about the results, he/she can apply for revaluation after paying the prescribed fee for the purpose, within one week from the announcement of results.

A committee will be constituted by the concerned Head of the Department comprising of the Chairperson of the concerned Class Committee (Convener), the teacher concerned and a teacher of the department who is knowledgeable in the concerned course. If the Committee finds that the case is genuine, it may jointly revalue the answer script and forward the revised marks to the Controller of Examinations with full justification for the revision, if any.

18.3 The “U” and “AB” grade once awarded stays in the grade sheet of the students and is not deleted when he/she completes the course successfully later. The grade acquired by the student later will be indicated in the grade sheet of the appropriate semester.

19.0 COURSE REPETITION AND ARREARS EXAMINATION

19.1 A student should register to re-do a core course wherein "I" or "W" grade is awarded. If the student is awarded "I" or "W" grade in an elective course either the same elective course may be repeated or a new elective course may be taken.

19.2 A student who is awarded "U" or "AB" grade in a course shall write the semester-end examination as arrear examination, at the end of the next semester, along with the regular examinations of next semester courses.

19.3 A student who is awarded "U" or "AB" grade in a course will have the option of either to write semester end arrear examination at the end of the subsequent semesters, or to redo the course whenever the course is offered. Marks earned during the redo period in the continuous assessment for the course, will be used for grading along with the marks earned in the end-semester (re-do) examination.

19.4 If any student obtained "U" or "AB" grade, the marks earned during the redo period for the continuous assessment for that course will be considered for further appearance as arrears.

19.5 If a student with "U" or "AB" grade prefers to redo any particular course fails to earn the minimum 75% attendance while doing that course, then he/she will not be permitted to write the semester end examination and his / her earlier 'U' grade and continuous assessment marks shall continue.

20.0 GRADE SHEET

20.1 The grade sheet issued at the end of the semester to each student will contain the following:

(i) the credits for each course registered for that semester.

(ii) the performance in each course by the letter grade obtained.

(iii) the total credits earned in that semester.

(iv) the Grade Point Average (GPA) of all the courses registered for that semester and the Cumulative Grade Point Average (CGPA) of all the courses taken up to that semester.

20.2 The GPA will be calculated according to the formula

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i} \qquad Where\ \ n = number\ of\ courses$$

where Ci is the number of credits assigned for i^{th} course

GP_i - Grade point obtained in the i^{th} course

For the cumulative grade point average (CGPA) a similar formula is used except that the sum is over all the courses taken in all the semesters completed up to the point of time.

'I' and 'W' grades will be excluded for GPA calculations.

'U', 'AB' 'I' and 'W' grades will be excluded for CGPA calculations.

20.3 Classification of the award of degree will be as follows:

CGPA	Classification
8.50 and above, having completed all courses in first appearance	First class with Distinction
6.50 and above, having completed within a period of 2 semesters beyond the programme period	First Class
All others	Second Class

However, to be eligible for First Class with Distinction, a student should not have obtained U or I grade in any course during his/her study and should have completed the PG Programme within a minimum period covered by the minimum duration (clause 3.1) plus authorized break of study, if any (clause 8). To be eligible for First Class, a student should have passed the examination in all courses within the specified minimum number of semesters reckoned from his/her commencement of study plus two semesters. For this purpose, the authorized break of study will not be counted. The students who do not satisfy the above two conditions will be classified as second class. For the purpose of classification, the CGPA will be rounded to two decimal places. For the purpose of comparison of performance of students and ranking, CGPA will be considered up to three decimal places.

21.0 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

21.1 A student shall be declared to be eligible for the award of the Masters Degree, if he/she has:

i) successfully acquired the required credits as specified in the Curriculum corresponding to his/her programme within the stipulated time,

ii) no disciplinary action is pending against him/her.

21.2 The award of the degree must be approved by the University.

22.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

CURRICULUM & SYLLABI FOR M.TECH. (ELECTRONICS AND INSTRUMENTATION ENGG) (FOUR SEMESTERS / FULL TIME)

CURRICULUM

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
1.	MAB 6187	Applied Mathematics for Instrumentation Engineers	3	1	0	4
2.	EIB 6101	Research Methodology	3	0	0	3
3.	EIB 6102	System Theory	3	1	0	4
4.	EIB 6103	Process Control	3	0	0	3
5.	EIB 6104	Real time Embedded System	3	0	0	3
6.		Elective - I	3	0	0	3
7.	EIB 6105	Process Control Laboratory	0	0	4	2
8.	EIB 6106	Seminar	0	0	2	1
						23

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
1.	EIB 6211	Advanced Process Control	3	0	0	3
2.	EIB 6212	Instrumentation System Design	3	0	0	3
3.	EIB 6213	System Identification and Adaptive Control	3	0	0	3
4.	EIB 6214	Fault tolerant Control	3	0	0	3
5.		Elective - II	3	0	0	3
6.		Elective - III	3	0	0	3
7.	EIB 6215	Modeling and Simulation Laboratory	0	0	4	2
8.	EIB 6216	Design / Fabrication Project	0	0	4	2
						22

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
1.		Elective - IV	3	0	0	3
2.		Elective - V	3	0	0	3
3.		Elective - VI	3	0	0	3
4.	EIB 7102	Project Management	3	0	0	3
5.	EIB 7101	Project Work Phase - I	0	0	12	6*
6.	EIB 6217	Industrial Training	0	0	#	1
						13

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
1.	EIB 7101	Project Work Phase - II	0	0	36	18*
						18 + 6 = 24

* Credits for Project Work Phase I to be accounted along with Project Work Phase II in IV semester

TOTAL CREDITS : 82

LIST OF ELECTIVES

ELECTIVE - I

Sl. No	Course Code	Course
1.	EIBY 01	Applied Industrial Instrumentation
2.	EIBY 02	Applied Biomedical Instrumentation
3.	EIBY 03	Advanced Fiber Optic & Laser Instrumentation
4.	EIBY 04	Robotics and Automation

ELECTIVE - II

1.	EIBY 21	Applied Analytical Instrumentation
2.	EIBY 22	Process Modeling and Simulation
3.	EIBY 23	Microcontroller based Digital Control System
4.	EIBY 24	Computer Networks

ELECTIVE - III

1.	EIBY 31	Virtual Instrumentation
2.	EIBY 32	Applied Programmable Logic Control and Distributed Control System
3.	EIBY 33	Process Optimization
4.	EIBY 34	Advanced VLSI Design
5.	EIBY 35	Wireless Sensor Network

ELECTIVE - IV

1.	EIBY 41	Optimal Control
2.	EIBY 42	Computer aided design for Instrumentation Systems
3.	EIBY 43	Biosignal Processing
4.	EIBY 44	Digital Image Processing

ELECTIVE - V

1.	EIBY 51	Robust Control
2.	EIBY 52	Digital Instrumentation
3.	EIBY 53	Application of MEMS Technology
4.	EIBY 54	Physiological Control Systems

ELECTIVE - VI

1.	EIBY 61	Bio-MEMS
2.	EIBY 62	Multivariable Control
3.	EIBY 63	Applied soft computing for Process Modeling, Control and Optimization
4.	EIBY 64	Power Electronics for Renewable Energy Systems
5.	EIBY 65	Nanotechnology and its applications
6.	EIBY 66	Introduction to Cognitive Neuroscience
7.	SSBY 01	Society, Technology & Sustainability

SEMESTER I

MAB6187	**APPLIED MATHEMATICS FOR INSTRUMENTATION ENGINEERS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

OBJECTIVES:

- To introduce the basic concepts in Calculus of Variations and nonlinear differential equations.
- To impart knowledge on probability and random variables.
- To expose to techniques in solving Linear and Integer Programming problems.

MODULE I CALCULUS OF VARIATION **8**

Euler's equation - several dependent variables Lagrange's equations of Dynamics - Integrals involving derivatives higher that the first - Problems with constraints - Direct methods and eigenvalue problems.

MODULE II NONLINEAR ORDINARY DIFFERENTIAL EQUATION **8**

Equations, with separable variables - Equations reducible to linear form - Bernoullis equation - Riccati's equation - Special forms of Riccati's equation - The Lane Emden equation - The nonlinear Pendulum - Duffing equation.

MODULE III PROBABILITY **8**

Probablity concepts – Baye's theorem – Random variables – Density, distribution functions - Standard distributions: Binomial, Poisson, Normal, Exponential –Correlation and Regression.

MODULE IV RANDOM PROCESSES **8**

Classification - Stationary Random Process - Markov Process - Gaussian Process - Markov chain - Auto correlation - Cross correlation.

MODULE V LINEAR PROGRAMMING **8**

Simplex algorithm - Two phase and Big-M Techniques - Duality theory - Dual simplex method.

MODULE VI INTEGER PROGRAMMING **5**

Formulation – Gomory's IPP method – Gomory's mixed integer method – Branch and bound technique.

L – 45; T – 15; Total Hours : 60

REFERENCES:

1. Gupta, A.S., "Calculus of variations with applications", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Stephenson, O., Radmore, P.M., "Advanced Mathematical Methods for Engineering and Science students", Cambridge University Press, 1999.
3. Bronson, R., "Matrix Operations, Schaum's outline series", McGraw Hill, New York, 1989.
4. Taha, H.A., "Operations Research - An Introduction", 9th edition, Pearson Prentice Hall, 2011.
5. Medhi, J., "Stochastic Processes", Wiley Eastern Ltd., 1994.
6. Elsgolts, L.E., "Differential equations and calculus of variations", University Press of the Pacific, 2003.

OUTCOMES:

The students will be able to

- Solve problems in Calculus of Variations and nonlinear Ordinary Differential Equations.
- Solve problems in random variables.
- Use different techniques in solving Linear Programming and Integer Programming problems.

EIB6101	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce scholars to a number of perspectives on research and to broaden their conceptions of what research involves.
- To provide knowledge on research design, information retrieval, problem formulation, use of statistical techniques, evaluation and writing of research reports, papers and ethics in research.

MODULE I RESEARCH PROBLEM FORMULATION **7**

Research - objectives - types, Research process, solving engineering problems Identification of research topic - formulation of research problem, literature survey and review.

MODULE II RESEARCH DESIGN **8**

Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle - important experimental designs, Design of experimental setup, Mathematical modeling - Simulation - validation and experimentation, Dimensional analysis - similitude.

MODULE III USE OF STATISTICAL TOOLS IN RESEARCH **12**

Importance of statistics in research - concept of probability – popular distributions - sample design. Hypothesis testing, ANOVA, Design of experiments - factorial designs - orthogonal arrays, Multivariate analysis - correlation and regression, Curve fitting.

MODULE IV ANALYSIS AND INTERPRETATION OF DATA **10**

Research Data analysis - interpretation of results- correlation with scientific facts - repeatability and reproducibility of results - accuracy and precision - limitations, Use of optimization techniques - Traditional methods – evolutionary optimization techniques.

MODULE V THE RESEARCH REPORT **8**

Purpose of written report - audience - synopsis writing - preparing papers for International Journals, Thesis writing - organization of contents - style of writing

- graphs and charts - referencing, Oral presentation and defence, Ethics in research, Patenting, IPR.

Total Hours : 45

REFERENCES:

1. Kothari C.R., Research, Methodology - Method and Techniques. New Age International (P) Ltd., New Delhi, Reprint 2009.
2. Doebelin, Ernest O., Engineering Experimentation: planning, execution, reporting, McGraw - Hill International International edition, 1995.
3. George E. Dieter., Engineering Design, McGraw Hill - International edition, 2000.
4. Rao S.S. Engineering Optimization - theory and Practice, New Age International (P) Ltd., New Delhi, 2008.
5. Madhav S. Phadke, Quality Engineering using Robust Design, Printice Hall, Eaglewood Cliffs, New Jersey, 1989.
6. Dan Jones, Technical writing style, Pearson Education Company, Massachusetts, 1998.
7. Abdul Rahim R., Thesis writing: A Manual for Researchers, New Age International (P) Ltd., 1996.

OUTCOMES:

The students will be able to

- implement perspectives and conceptions of research.
- formulate research problem, research design and writing of research reports, papers in academic and Research and Development activities.

EIB6102	SYSTEM THEORY	L	T	P	C
	(Prerequisite: Control System)	3	1	0	4

OBJECTIVES:

- To provide knowledge on state space approach, state feedback controllers and observers for different processes.
- To acquire skill on optimal control based on state space approach.
- To enhance knowledge on stability analysis of multivariable processes.
- To introduce nonlinear systems and its linearization methods.

MODULE I STATE SPACE APPROACH 9

System representation in state variable form – State transition equation – Methods of computing the state transition matrix - Stability analysis - Controllability and observability of linear time invariant systems.

MODULE II STATE FEEDBACK CONTROL AND STATE ESTIMATOR 9

State Feedback – Output Feedback – Pole placement technique – Full order and Reduced Order Observers – Deadbeat Observers – Dead beat Control

MODULE III OPTIMAL CONTROL BASED ON STATE SPACE APPAROACH 9

Formulation of the optimal control problem – method of calculus of variations – use of Hamiltonian Method – Pontryagin's Minimum Principle - Optimal Control Problem – Hamilton – Jacobi Approach – Continuous Time Linear State Regulator Matrix - Riccati Equation – Methods of Solution – State Variable Feedback Design.

MODULE IV NON-LINEAR SYSTEMS 9

Types of Non-Linearity – Typical Examples – Phase plane analysis (analytical and graphical methods) – Limit cycles – Equivalent Linearization – Describing Function Analysis, Describing Functions for different non-linear elements.

MODULE V STABILITY OF NON-LINEAR SYSTEMS 9

Stability concepts – Equilibrium points – BIBO and Asymptotic stability – Stability

Analysis by DF method – Lyapnov Stability Criteria – Krasovskil's method – Variable Gradient Method – Popov's Stability Criterion.

Total Hours : L - 45, T - 15 = 60

REFERENCES:

1. I. J. Nagrath, Madan Gopal, "Control Systems", New Age International Publishers, 2009
2. U.A. Bakshi, V.U. Bakshi, "Control Systems", Technical Publications, 2010
3. K. Ogata, Modern Control Engineering, 4th ed., Pearson Education, Delhi, 2002
4. R.C. Dorf and R.H. Bishop, Modern Control Systems, 10th ed., Pearson Education, Delhi, 2004
5. M. Gopal, "Modern Control System Theory", Wiley Eastern Limited, 2nd edition, 1996.
6. K.Ogata, "Modern Control Engineering", PHI, 3rd Edition, 1997.
7. M. Gopal, "Control System Principles and Design", 2nd Edition, 2002.
8. W. L. Luyben, "Process Modeling, simulation and control for Chemical Engineers", 2nd edition, McGraw Hill.
9. D.P. Atherton, "Stability of non linear systems", Prentice Hall, 1986.

OUTCOMES:

The student will be able to

- Implement state space approach for the process and obtain the solution.
- Design state feedback controller and observers.
- Perform stability analyses of the system using conventional mathematical approach and describing function.
- Have the ability to analyse and solve problems and to execute projects.

EIB6103	PROCESS CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To equip the students with the knowledge of modeling a physical process.
- To acquire knowledge on various control schemes.
- To introduce students to fundamental principles in system dynamics and control.

MODULE I PROCESS DYNAMICS 9

Need for process control – Review of Laplace transform and z-transform – Modified of z-transform – Pulse transfer function - Continuous and batch processes – Self regulation – Servo and regulatory operations – Interacting and non-interacting systems – Degrees of freedom - Linearization of nonlinear systems- Mathematical model of Level and Thermal processes – Lumped and Distributed parameter models - Identification of Transfer function model parameters using non-parametric approaches- state space model representation.

MODULE II CONTROL ACTIONS & FINAL CONTROL ELEMENTS 9

Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Electronic PID controller –Digital PID algorithm – Auto/manual transfer - Reset windup – Practical forms of PID Controller - Pneumatic and electric actuators – Valve Positioner – Control Valves – Characteristic of Control Valves:- Inherent and Installed characteristics – Modeling of pneumatic control valve

MODULE III CONTROLLER TUNING –SINGLE LOOP REGULATORY CONTROL 9

Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio - Tuning:- Process reaction curve method, Continuous cycling method and Damped oscillation method – Determination of optimum settings for mathematically described processes using time response and frequency response approaches –pole placement –lamda tuning- algebraic design – optimization methods – robust loop shaping

MODULE IV ENHANCEMENT TO SINGLE LOOP REGULATORY CONTROL AND MODEL BASED CONTROL SCHEMES 9

Feed-forward control – Ratio control – Cascade control – Inferential control – Split-range – override control–- selective control –Auto tuning - Smith predictor control scheme- Internal Model Controller- IMC PID controller -Single variable Model predictive control – Single Loop DMC – Generalized Predictive Control

MODULE V PIPING AND INSTRUMENTATION DIAGRAM EVALUATION, PREPARATION AND CONTROL SYSTEMS FOR PROCESS OPERATION 9

P & I D Symbols, line numbering, line schedule, P & I D development, various stages of P & ID-P& ID for pumps, compressors process vessels, absorber, and evaporator - control system for heater, distillation column, and expander.

Total Hours : 45

REFERENCES:

1. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
2. Stephanopoulos, G., “Chemical Process Control - An Introduction to Theory and Practice”, Prentice Hall of India, 2005.
3. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”, Wiley John and Sons, 2nd Edition, 2003.
4. Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw – Hill International Edition, 2004.
5. Ernest E.Ludwig, Applied Process Design for Chemical and Petrochemical Plants Vol-I, Gulf Publishing Company, Houston, 1989.
6. Max. S. Peters and K.D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 4th Edition, McGraw Hill Inc., New York, 1991.

OUTCOMES:

The students will be able to

- Apply conservation and accounting principles to model the dynamics of simple process systems.
- Effectively Model a physical process and apply control system.
- Design various controller and controller tuning
- Design, construct and evaluate control systems for process operations

EIB6104	REAL TIME EMBEDDED SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide a general introduction to real-time computer control systems, functionality and implementation platforms.
- To learn design parameters for real-time systems.
- To expose knowledge on methodologies and designing real time systems.

MODULE I INTRODUCTION TO REAL TIME SYSTEMS 9

Fundamentals of systems and real time system - Definitions, classification, features, issues and challenges - Introduction to real time operating systems – timeliness, scheduling and resource management - Implementation examples with commercial VxWorks and µC/Os.

MODULE II REAL TIME SYSTEM DESIGN AND ANALYSIS 9

Real time specification and design techniques-models-real time kernels-Characteristics and attributes of Real Time Kernel-kernel service-kernel implementation, performance analysis and optimization – Testing and Validation

MODULE III EMBEDDED SYSTEM COMPONENTS AND ITS INTERFACE 9

Embedded system definition- architecture and standards with examples-Embedded hardware-processors-memory devices-Interface and Peripherals-Power and its Management.

MODULE IV EMBEDDED SYSTEM DESIGN AND DEVELOPMENT 9

Design methods and techniques – models and languages - state machine and state tables in embedded design – High level language descriptions in embedded system, Java based embedded system design – Simulation and Emulation of embedded systems- ARM processor based embedded boards-Examples with Microcontroller based embedded system development.

MODULE V CASE STUDIES 9

Case studies of sector specific, time - critical and safety - critical real time embedded systems- Typical applications in automotives, communication,

medicine and manufacturing- engine controls and antilock braking systems, Embedded mobile communication and positioning devices, pacemaker and patient monitoring systems, Robotics and control systems.

Total Hours : 45

REFERENCES:

1. Phillip A. Laplante, 'Real-Time Systems Design and Analysis: An Engineer's Handbook', Wiley Publications, 2004
2. Raymond J.A.Buhr Donaid L. Balley: An introduction to real time Embedded Systems, Prentice Hall International, 1999.
3. C.M. Krishna, Kang G.Shin, Real Time Systems, McGraw Hill, 1997.
4. Herma K,Real Time systems – Design for distributed embedded applications, Kluwer academic,1997.
5. Tamy Noergaard, Embedded Systems Architecture, ElseiverInc, 2005
6. D.E.Simon, An Embedded Software primer, Addison Wesley, 1999.
7. Gajski D.D. Vahid, F.,Narayan S.,Specification and design of embedded systems, PTR prentice hall, 1994
8. Arnold S.Berge, Embedded system design-An introduction to processors, tools and techniques, CMP Books, 1st Edition, 2002.

OUTCOMES:

The students will be able to

- differentiate the different issues that arise in designing soft and hard real-time, concurrent, reactive, safety-critical and embedded systems.
- analyze and apply a variety of scheduling mechanisms suitable for soft and hard real-time systems.
- evaluate the additional problems that arise in developing distributed and networked real-time systems.
- apply systems engineering methods and techniques in the design and analysis of real-time systems.

EIB6105	PROCESS CONTROL LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To provide knowledge on controller design, tuning and stability.
- To model and simulate MIMO system, nonlinear system.
- To enhance knowledge on state feedback controllers and observers.
- To learn various control schemes for MIMO processes.

LIST OF EXPERIMENTS

1. Simulation of lumped parameters system
2. Simulation of distributed parameter system
3. PID Control
   a. Design of PID controller
   b. Autotuning of PID controller
   c. PID Implementation Issues
   d. PID Enhancements
4. Distributed Control System
   a) Study of Distributed Control System.
   b) On-Line control using Distributed Control System
5. Design of State Feedback Controller and State Observer
6. Design of Single Variable Internal Model Controller
7. Design of Single Variable Model Predictive Controller
8. Design of Single loop DMC
9. Design of dead time compensation
10. Study of P&ID Diagram
11. Embedded PC as PID

Total Hours : 45

OUTCOMES:

The student will be able to

- Design state feedback controller and observers for various processes.
- Implement advanced control schemes to various processes.

SEMESTER II

EIB6211	ADVANCED PROCESS CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on multivariable system and multi-loop regulatory control.
- To learn time-varying and nonlinear system

MODULE I MULTIVARIABLE SYSTEMS 9

Multivariable Systems – Transfer Matrix Representation – State Space Representation – Poles and Zeros of MIMO System - Directions in multivariable systems - Singular value decomposition

MODULE II MULTI-LOOP REGULATORY CONTROL 9

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 – LQG Control – RGA for Non-square Plant

MODULE III MULTIVARIABLE REGULATORY CONTROL 9

Introduction to Multivariable control –Multivariable PID Controller -Multivariable IMC– Multivariable Dynamic Matrix Controller -Multivariable Model Predictive Control –Generalized Predictive Controller – Multiple Model based Predictive Controller – Constrained Model Predictive Controller - Implementation Issues

MODULE IV CONTROL OF TIME-VARYING AND NONLINEAR SYSTEMS 9

Models for Time-varying and Nonlinear systems – Input signal design for Identification –Real time parameter estimation – Gain Scheduling for Nonlinear process - Nonlinear PID Controller - Control of Hammerstein and Wiener Systems

MODULE V CASE STUDIES 9

Control Schemes for Distillation Column, CSTR, Bioreactor, Drug Infusion System, Quadruple tank system and pH Process.

Total Hours : 45

REFERENCES:

1. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
2. Stephanopoulos, G., “Chemical Process Control - An Introduction to Theory and Practice”, Prentice Hall of India, 2005.
3. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”, Wiley John and Sons, 2nd Edition, 2003.
4. Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw -Hill International Edition, 2004.
5. E. Ikonen and K. Najim, “ Advanced Process Identification and Control”, Marcel Dekker, Inc. Newyork, 2002.
6. P. Albertos and S. Antonio, “Multivariable Control Systems An Engineering Approach”, Springer Verlag, 2004.
7. Sigurd Skogestad, Ian Postlethwaite, “Multivariable Feedback Control: Analysis and Design”, John Wiley and Sons, 2004.

OUTCOMES:

The student will be able to

- analyze the interaction of the multi loop system for various processes.
- design a Multi Loop Controller and Multivariable Controller.
- perform nonlinear control of the process using advanced control schemes.

EIB6212 INSTRUMENTATION SYSTEM DESIGN L T P C

3 0 0 3

OBJECTIVES:

- To provide knowledge on signal conditioning circuits.
- To learn about transmitters, data loggers and annunciators.
- To enhance knowledge on selection of control valves and flow meters.

MODULE I DESIGN OF SIGNAL CONDITIONING CIRCUITS 9

Design of V/I Converter and I/V Converter- Analog and Digital Filter design – Signal conditioning circuit for pH measurement –Compensation circuit – Signal conditioning circuit for Temperature measurement - Cold Junction Compensation – software and Hardware approaches –Thermocouple Linearization.

MODULE II DESIGN OF TRANSMITTERS 9

RTD based Temperature Transmitter – Thermocouple based Temperature Transmitter- Capacitance based Level Transmitter –Smart Flow Transmitters.

MODULE III DESIGN OF DATA LOGGER AND PID CONTROLLER 9

Design of ON / OFF Controller using Linear Integrated Circuits- Electronic PID Controller – Microcontroller Based Digital PID Controller – Microcontroller based Data Logger – PC based Data Acquisition Cards.

MODULE IV ORIFICE AND CONTROL VALVE SIZING 9

Orifice Sizing: - Liquid, Gas and steam services - Control Valves – Valve body:- Commercial valve bodies – Control valve sizing – Liquid, Gas and steam Services – Cavitation and flashing –Selection criteria – Rotameter Design.

MODULE V DESIGN OF ALARM AND ANNUNCIATION CIRCUIT 9

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

Total Hours : 45

TEXT BOOKS:

1. C. D. Johnson, “Process Control Instrumentation Technology”, 8th Edition, Prentice Hall, 2006.
2. Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2005.
3. R.W. Miller, “Flow Measurement Engineering Handbook”, Mc-Graw Hill, New York1996, 3rd Edition.

OUTCOMES:

The students will be able to

- select the field instruments according to the process.
- formulate design specifications for instrumentation systems.
- effectively carry out operation and maintenance of process automation in industries.

EIB6213	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on input-output experimental data for identification of mathematical dynamical models.
- To expose non-parametric, parametric and intelligent identification.
- To enhance knowledge on various adaptive schemes.

MODULE I MODELS FOR IDENTIFICATION 9

Models of LTI systems: Linear Models-State space Models-OE model- Model sets, Structures and Identifiability - Models for Time-varying and Non-linear systems – Non-linear state-space models-Black box models, Fuzzy models.

MODULE II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATION 9

Transient response and Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square – Recursive Least Square –Forgetting factor- Maximum Likelihood – Instrumental Variable methods.

MODULE III NON-LINEAR IDENTIFICATION AND MODEL VALIDATION 9

Open and closed loop identification: Approaches – Direct and indirect identification –Joint input-output identification – Non-linear system identification– Wiener models –Power series expansions - State estimation techniques – Non linear identification using Neural Network and Fuzzy Logic.

MODULE IV ADAPTIVE CONTROL AND ADAPTATION TECHNIQUES 9

Introduction – Uses – Auto tuning – Self Tuning Regulators (STR) – Model Reference Adaptive Control (MRAC) – Types of STR and MRAC – Different approaches to self tuning regulators – Stochastic Adaptive control.

MODULE V CASE STUDIES 9

Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

Total Hours : 45

REFERENCES:

1. Ljung, “System Identification Theory for the User”, PHI, 1987.
2. Torsten Soderstrom, Petre Stoica, “System Identification”, Prentice Hall International (UK) Ltd,1989.
3. Astrom and Wittenmark, “Adaptive Control”, Prentice Hall Publication, 2nd Edition 1994.
4. William S. Levine, “Control Hand Book”, CRC Press INC. Publication.
5. Narendra and Annasamy, ”Stable Adaptive Control Systems”, Dover Publications, 2005.

OUTCOMES:

The students will be able

- to implement the modeling and simulation in various processes.
- to perform nonlinear control using adaptive schemes.

EIB6214	FAULT TOLERANT CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on fault detection and diagnosis.
- To expose modular redundancy concept.
- To have knowledge on formulation, implementation and detection of faults.
- To acquaint with fault design and parametric fault.
- To provide knowledge on various intelligent techniques for fault diagnosis.

MODULE I INTRODUCTION 9

Introduction-Scope - Approaches to fault detection and diagnosis:-Model free methods and Model based methods -Introduction to Random variables-Distribution Bivariated distribution-Multivariate distribution-Normal distribution-Maximum likelihood distribution-Hypothesis testing.

MODULE II ANALYTICAL REDUNDANCY CONCEPT 9

Additive faults and disturbance-Multiplicative faults and disturbance –Residual generation-Detection property-Isolation property Computational of Residual generation-Specification and implementation.

MODULE III PARITY EQUATION IMPLEMENTATION OF RESIDUAL GENERATOR 9

Parity equation formulation Implementation of single residual-Implementation with input output relation-Fault system matrix Design for structure residual-Structural definition-Canonical structures-Handling disturbance-Residual structure for multiple faults.

MODULE IV DESIGN FOR DIRECTIONAL RESIDUAL 9

Design for directional residual-Directional specifications-Parity equation-Linearly dependent columns Residual generation for parametric faults-Representation of parametric fault-Design for parametric fault and model errors-Robustness in residual generation-Perfect decoupling from disturbance.

MODULE V ADVANCE TOPICS **9**

Fault diagnosis using Kalman filtering-Fault diagnosis using principle component analysis - Fault diagnosis using ANN and Fuzzy clustering Case study: Aircraft fault detection.

Total Hours : 45

REFERENCES:

1. Janos.J.Gertler, “Fault detection and diagnosis in engineering system second edition, Marcel Dekker, 1998.

2. Rami S.Mangoubi, “Robust Estimation and Failure detection”, Springer-Verlag London, 1998.

OUTCOMES:

Students will have ability

- to formulate a structural model of a dynamical system.
- to design residual directional parametric faults.
- to formulate and design control techniques for various processes.

EIB6215	MODELING AND SIMULATION LABORATORY	L	T	P	C
	Pre-requisites: Control system, Process Control, Optimization	0	0	4	2

OBJECTIVES:

- To provide knowledge on controllers for process operations based on both theoretical and empirical process characterization.
- To acquire knowledge on virtual instrumentation, Embedded PC and SCADA.
- To give an exposure to various tool boxes in MATLAB.

LIST OF EXPERIMENTS

1. Identification of Linear dynamic model (Black-Box) of a process using non-parametric methods.
2. Identification of Linear dynamic model (Black-Box) of a process using parametric methods.
3. Identification of Grey-Box model of a process.
4. Identification of certain class of non-linear models using parametric methods.
5. Virtual Instrumentation Package.
6. Analysis of Multi-input Multi-output System
7. Analysis of Nonlinear Process
8. Design of Multi-Loop PID Controller using Biggest Log Modulus Tuning Method
9. Design of Gain scheduling controller
10. Design of Self-Tuning Controller
11. Design of Nonlinear PID Controller.
12. Simulation of PID controller using embedded KEIL

Total Hours : 45

OUTCOMES:

Students will have ability

- to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability.
- to carry out mini projects in Soft computing techniques and demonstrate it using MATLAB/LABVIEW.

EIB6216	DESIGN / FABRICATION PROJECT	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To acquire knowledge on designing of hardware as well as applications of softwares like CAD tool, Matlab, LabVIEW, MEMS & embedded C.
- To provide in-house solutions to assist the researcher through a complete life cycle of system development.

COURSE OUTLINE:

Project shall be carried out in the following areas,

- Design/ fabrication of sensors and transmitters,
- Microcontroller based digital control system design,
- Embedded system design for automation,
- Micro-electronics and VLSI Design,
- Applications of Digital image processing for process industries,
- Analysis and design of advanced process control techniques,
- Medical imaging and instrumentation,
- Microsensors and Microactuators design and
- MEMS in instrumentation and biomedical.

Total Hours : 45

SOFTWARE:

MATLAB/SIMULINK, PSPICE, LabVIEW and CAD tool, embedded C, MEMS software

OUTCOMES:

The student will be able to

- design, develop, and deploy advanced state-of-the-art instrument systems and custom application software in support of the ongoing experimental research efforts.
- apply basic and contemporary science, engineering, and experimentation skills to identify manufacturing problems and developing practical solutions.

SEMESTER III

EIB7102	PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge on project profile, planning the process, capital requirement and cost control systems.
- To give an exposure on plant engineering management, safety measures and government regulations.

MODULE I OVERVIEW OF PROJECT MANAGEMENT **9**

Project definition, Project Profile and standards, Feed back information (MIS), Evaluation and Modification, Selection, Criteria.

MODULE II PROJECT PLANNING **9**

Planning the process, Strategic and Managerial Planning, Organising the process planning, cost and costing, Cost Control systems, Economic Balancing, Network Planning, Methods (PERT/CPM), Engineering Flow Diagrams, Cost requirements, Analysis and Estimation of Process Feasibilities (Technical/Economical) Analysis, Cost – Benefit Ratio Analysis, Project Budgeting, Capital Requirements, capital Market, Cash Flow Analysis, Break even strategies.

MODULE III PROJECT DEVELOPMENT AND COMMISSIONING **9**

Plant Engineering Management, Objectives, Programme, Control, Plant Location and Site Selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Recommission, Commissioning and performance appraisal, Strategies choice and Influence, Product planning and development, Provision and maintenance of service facilities.

MODULE IV INDUSTRIAL SAFETY ANALYSIS **9**

Process safety, Materials safety and Handling regulations, Safety in equipment and machinery operations, Design considerations of safety organization and control, Pollution, Pollution control and Abatement, Industrial Safety Standard Analysis.

MODULE V REGULATION AND POLICIES **9**

Government regulations on procurement of raw materials and its allocation. Export – Import regulations, Pricing policy, Industrial licensing procedure, Excise and other commercial taxes, Policies on depreciation and corporate tax, Labour laws, Social welfare legal measurements, Factory act, Regulations of Pollution Control Board.

Total Hours: 45

REFERENCES:

1. Cheremisinoff, N. P., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press, 2001
2. Couper, J. R., Process Engineering Economics, CRC Press, 2003.
3. Perry, J. H. “Chemical Engineer’s Hand Book”, 8th Ed., McGraw Hill, New York, 2007.
4. Peters, M. S., Timmerhaus, C. D. and West, R. E., “Plant Design and Economics for Chemical Engineers”, 5th Edn., McGraw Hill, 2003.
5. Silla, H., Chemical Process Engineering: Design and Economics, CRC Press, 2003
6. Vinoski, W., Plant Management Handbook, Pearson Education, Limited, 1998
7. Watermeyer, P., Handbook for Process Plant Project Engineers, John Wiley and Sons, 2002

OUTCOME:

The student will be able to execute the project in effective and profitable manner

ELECTIVE – I

EIBY01	APPLIED INDUSTRIAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of different methods of measurements.
- To acquire knowledge on different types of measurements in process industries.
- To expose on energy conservation, management and safety pertaining to industries.

MODULE I OVERVIEW OF INDUSTRIAL INSTRUMENTATION 4

Measurement of Pressure-Temperature- Flow Level-Viscosity-Humidity

MODULE II MEASUREMENT IN THERMAL POWER PLANT 9

Parameters to be Measured in Thermal Power Plant – Fuel Flow- Air Flow-Drum Level-Steam Pressure-Steam Temperature-Analyzers-FLUE Gas Oxygen Analyzer- Paramagnetic Oxygen Analyzer-Zirconia Oxygen Analyzer-Dissolved Oxygen, Analyzer- Silica Analyzer- Pollution Monitoring Instruments-Smoke meter Dustmonitor.

MODULE III MEASUREMENT IN PETROCHEMICAL INDUSTRY 8

Selection-erection & commissioning of instruments – Temperature-flow pressure measurements in pyrolysis -catalytic cracking-reforming process intrinsic safety.

MODULE IV MEASUREMENT IN PULP AND PAPER – GRASS AND STEEL INDUSTRY 9

Paper and Pulp Wet End Instrumentation – Pressure-Vaccum Temperature-Level Flow-Dry and Instrumentation-Moisture-Coat Thickness-Optical Variables-Measurement of Length and Speed-Identification of Various Process Parameter in the Steel Industry-Selection of Suitable Measurement Hardware for Temperature Pressure Level Flow-Special Gauges for Measurement of Thickness and Shape-Graphic Displays-Alarm Management.

MODULE V INSTRUMENTATION FOR ENERGY CONSERVATION AND MANAGEMENT AND SAFETY 8

Instrumentation for Renewable Energy System-Energy Management Device (Peak Load Shedding)- Explosion Suppression – Flame Arrestors-Conservation Vents and Emergency Vents-Flame-Fire and Smoke Detectors-Sprinkler System – FRLS Cable System.

MODULE VI SPECIAL PURPOSE INSTRUMENTATION AND SYSTEM DESIGN 7

Explosive Gas Detection – Toxic Gas Monitoring Water Quality Monitoring. Ultrasonic Level, Flow, Measurements, Measurement of Length Mass Thickness-Flow, Level Using Nuclear Radiation-Process, Flow Sheet-Instrumentation Specification Sheet for Pressure, Temperature, Flow, Level etc., Control Panels.

Total Hours: 45

REFERENCES:

1. D.Patranabis, Principle of Industrial Instrumentation, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 1999.
2. John G. Webster, Measurement, Instrumentation and sensors Handbook, CRC press IEEE Press
3. Liptak B.G, Instrumentation Engineers Handbook (Measurement), Chilton Book Co., 1994.
4. Reay D.A. Industrial Energy conservation: A Hand Book for Engineer and Manager, Pergamon press, 2nd Edition, 1977.
5. Hodge b. K Analysis and design of energy systems, Prentice Hall, 3rd Edition (1999)
6. Liptak B.G, Instrument Engineers Handbook, CRC Press, 3rd Edition, (1995)
7. Ness S. Air monitoring for toxic explosions, air integrated approach,von nostrand.

OUTCOMES:

The student will be able to

- Select field instruments based on various applications in process industries.
- Implement energy conservation, management and safety measures in industries.

EIBY02 APPLIED BIO-MEDICAL INSTRUMENTATION L T P C

3 0 0 3

OBJECTIVES:

- To provide knowledge on biomedical measurable variables, standards and awareness of electrical safety of medical equipments.
- To have knowledge on modeling, simulation and analysis of biomedical signals.
- To expose the modern method of imaging techniques and analysis.
- To acquire the knowledge on implantable devices and orthotic devices.

MODULE I INTRODUCTION TO BIOMEDICAL MEASUREMENTS 7

Physiological systems and measurable variables- Nature and complexities of biomedical measurements- Medical equipment standards- organization, classification and regulation- Biocompatibility - Human and Equipment safety – Physiological effects of electricity, Micro and macro shocks, thermal effects.

MODULE II ADVANCES IN MODELING AND SIMULATIONS IN BIOMEDICAL INSTRUMENTATION 7

Modeling and simulation in Biomedical instrumentation – Difference in modeling engineering systems and physiological systems – Model based analysis of Action Potentials - cardiac output – respiratory mechanism and breath analysis - Blood glucose regulation and neuromuscular function.

MODULE III BIOMEDICAL SIGNALS AND THEIR ACQUISITIONS 9

Types and Classification of biological signals – Signal transactions – Noise and artifacts and their management - characteristics - Origin, recording schemes and analysis of biomedical signals: Electrocardiography (ECG), echocardiography, Mamogram, Electroencephalograhy(EEG) and Electromyography (EMG) – Processing and transformation of signals- applications of wavelet transforms in signal compression and denoising.

MODULE IV INSTRUMENTATION FOR DIAGNOSIS AND MONITORING 8

Advanced medical imaging techniques and modalities -Instrumentation and applications in monitoring and diagnosis- Computed tomography, Magnetic

Resonance Imaging and ultrasound- Algorithms and applications of artificial intelligence in medical image analysis and diagnosis-Telemedicine and its applications in telemonitoring.

MODULE V BIOMEDICAL IMPLANTS AND MICROSYSTEMS 8

Implantable medical devices: artificial valves, vascular grafts and artificial joints-cochlear implants - cardiac pacemakers – Microfabrication technologies for biomedical Microsystems- microsensors for clinical applications – biomedical microfluid systems.

MODULE VI PROSTHETIC AND ORTHOTIC DEVICES 6

Principal and components of prosthesis and orthoses – orthoses for spinal pain – orthoses for osteoporosis – Arm and foot orthoses – future trends and research in orthoses

Total Hours : 45

TEXT BOOK:

1. John G.Webster (editor), Medical Instrumentation Application and design, John Wiley & Sons, 2005.

REFERENCES:

1. Shayne Cox Gad, Safety Evaluation of Medical Devices, Marcel Deckle Inc, 2002.
2. Michael C. K. Khoo, Physiological Control Systems- Analysis Simulation and Estimation, 2001.
3. Rangaraj M.Rangayan, Biomedical Signal Analysis: A Case Study Approach, Wiley Interscience, 2001.
4. John M.Semmlow, Biosignal and Bio medical Image processing, CRC Press, 2004.
5. Joseph J. Carr and John M Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 4th revised edition, 2004.

OUTCOMES:

The student will be able to

- model and simulate the biomedical systems, and to analyse biomedical measurable variables.
- analyze Imaging techniques, and have enhanced knowledge on implantable and prosthetic devices.

EIBY03	ADVANCED FIBER OPTIC AND LASER INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To introduce the basic concepts of Optical Fibers and Lasers and their applications in the field of Instrumentation.

MODULE I OPTICAL FIBERS AND THEIR PROPERTIES 9

Principles of light propagation through a fiber - Different types of fibers and their properties — Fiber materials and their characteristics - Transmission characteristics of fibers - absorption losses - scattering losses — Dispersion – Connectors and splicers - Optical sources - Optical detectors.

MODULE II INDUSTRIAL APPLICATION OF OPTICAL FIBERS 9

Fiber optic instrumentation system - Fiber optic sensors Different types of modulators -Application in instrumentation - Interferometric method of measurement of length -Measurement of pressure, temperature, current, voltage, liquid level and strain.

MODULE III LASER FUNDAMENTALS 9

Fundamental characteristics of laser - three level and four level lasers - properties of lasers - laser modes - resonator configuration - Q-switching and mode locking - cavity dumping - types of laser - gas laser, solid laser, liquid laser - semi conductor laser.

MODULE IV LASERS IN MEASUREMENTS AND TESTING 9

Laser for measurement of distance, length, velocity, acceleration, current, voltage, and atmospheric effect - material processing - laser heating, welding, melting and trimming of materials - removal and vaporization. Holography - Basic principle; methods; Holographic interferometry and applications; Holography for non-destructive testing - Holographic components

MODULE V MEDICAL APPLICATIONS OF LASERS 9

Medical applications of lasers; laser and tissue interaction - Laser instruments for surgery. Removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology, endoscopy, photodynamic laser surgery and oncology.

Total Hours : 45

REFERENCES:

I. John and Harry, Industrial lasers and their applications, McGraw Hill, 1st Edition, 1974.

2. John F Ready, Industrial applications of lasers, Academic press, 2nd Edition, 1978.

3. John Crisp & Darry Elliott, Introduction to Fiber Optics, Newnes Publication, 3rd Edition 2005.

4. Jasprit Singh, Semi Conductor Optoelectronics: Physics & Technology, McGraw Hill, ISE Edition, 1995.

5. Silvano Donati, Electro-optical Instrumentation Sensing and Measurement with Laser, Prentice Hall, 1st Edition, 2004.

OUTCOMES:

The student will be able to

- select and use optical fibers in various industrial applications.
- implement applications of LASER on Instrumentation and Biomedical Field.

EIBY04	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on Robotics & Automation and its applications.
- To expose to control issues and material handling in various industries.

MODULE I INTRODUCTION AND ROBOT KINEMATICS **9**

Basic concepts of Robots and automation-classification-specifications-Application-Notation-Direct Kinematics-Co-ordinate frames-rotations-Homogeneous coordinates-The Arm equation-Kinematic analysis of a typical Robot -Inverse Kinematics -Tool configuration-Inverse kinematics of a typical Robot -Workspace analysis and trajectory planning-Work envelope of different robots-The pick and place operation

MODULE II DYNAMIC OF ROBOTS **9**

Continuous path motion-interpolated motion-Straight line motion-Tool configuration Jacobian matrix and manipulator Jacobian-Manipulator Dynamics--Kinetic of potential energy-Energized forces- Lagrange's Equation -Euler Dynamic model.

MODULE III ROBOT CONTROL **6**

The control problem-state equation-Single axis PID control-PD gravity control-Computed torque control-Variable Structure control-Impedance control.

MODULE IV ROBOT VISION & MICRO ROBOTICS **12**

Fundamentals of Robot applications-Robot vision –Image representation-Template-matching-polyhedral objects-Shape analysis- Segmentation – Iterative processing -Robot cell design-Types of applications-material handling applications-Machine loading and unloading-spot welding-arc welding-spray painting-Micro Robotics and MEMS- Fabrication technology for micro robotics, Stability issues in legged robots, under actuated manipulators.

MODULE V MOBILE ROBOTS AND CONTROL ISSUES **9**

Industrial automation-General layout-general configuration of an automated flow line-conveyor systems - major features – types - Roller, State wheel,

Belt, Chain and overhead trolley-Inspection station with feedback loops to up steam workstations-shop floor control-3 phases-order scheduling

Total Hours : 45

REFERENCES:

1. Saeed B.Niku, “Introduction to robotics- Analysis, Systems, Application” Prentice Hall of India Pvt. Ltd., 2008.
2. Koren, “Robotics for Engineers”, McGraw Hill International Company. Tokyo 2005.
3. Vokotravotic, “Introduction to Robotics”, Springer, 1985.
4. K.S.Fu, R.C.Gonzally, C.S.G. Lee, “Robotics Control, Sensing, Vision and Intelligent”, Mcgraw Hill Book Company,1997.
5. Robort J.Schilling, “Fundamentals of robotics- Analysis and Control, Prentice Hall of India Pvt. Ltd., 2002.

OUTCOMES:

The student will be able to

- mathematically analyse planar & simple spatial robotic systems for industrial applications.
- utilize his knowledge for production and assembly process in industries.

ELECTIVE – II

EIBY21	**APPLIED ANALYTICAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- To provide knowledge on selection process and various techniques for analysis.
- To expose X-ray, NMR and emission spectroscopy.
- To have knowledge on atomic absorption spectroscopy.
- To study the thermal and chromatographic methods of analysis
- To make the students learn about the electrochemical instruments for application

MODULE I ANALYZER SELECTION AND SEPARATION TECHNIQUES 10

Introduction -The Selection Process - Problem Definition -Technique or Analyzer Selection - Classification of instrumental methods -Separation Techniques: introduction to spectroscopy – properties of EMR – EM Spectrum -UV spectroscopy- Instrumentation – applications- Theory of IR – Instrumentation –Applications- Raman spectroscopy- Mechanism for Raman effect- Instrumentation – Applications.

MODULE II X-RAY, NMR AND EMISSION SPECTROSCOPY 9

X-ray – Instrumentation for X-ray spectrometry- X-ray diffractometer- X-ray absorption-Introduction to NMR – Quantum description of NMR – Instrumentation – Chemical shift – spin – spin coupling –applications- theory of emission spectroscopy – instrumentation- applications

MODULE III MASS AND ATOMIC ABSORPTION SPECTROSCOPY 8

Theory of mass spectrometer – components of mass spectrometer - applications– Principles of atomic Absorption Spectroscopy – Instrumentation – Single and Double beam Atomic Absorption Spectrometers

MODULE IV THERMAL METHODS AND CHROMATOGRAPHY 10

Introduction to thermal methods analysis – thermo gravimeter – differential thermal analysis- Chromatography- Basic parts of chromatography- Methods of measurement – Liquid chromatography – Types- amino acid analyzer- HPLC - Gas Chromatography

MODULE V ELECTROCHEMICAL INSTRUMENTS 8

Electrochemical cell - Types of Electrodes - Conductivity meter – Polorography – Coulometers – Amperometers - Aqua meter - PH meters - Selective ion electrodes.

Total Hours: 45

TEXT BOOK:

1. H.H. Willard, L.L. Merit, J.A. Dean, F.A. Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, New Delhi, (2012). (Unit I, II & III)
2. R.S. Khandpur, Handbook of analytical instrumentation, Tata McGraw Hill Pvt Ltd., New Delhi, (2001). (Unit IV & V)

REFERENCES:

1. Skoog, D.A. and West D.M., Principles of Instrumental Analysis, Holt Sounder Publication, Philadelphia, 1985.
2. Robert D. Braun, Introduction to Instrumental Analysis, McGraw — Hill, Singapore, 1987.
3. Ewing G.W, Instrumental Methods of Analysis, McGraw- Hill, 1992.
4. Frank A.Settle, Handbook jf. Instrumental Techniques for Analytical Chemistry, Prentice Hall, New Jersey, 1997.
5. G.Chatwal, S.Anand, Instrumental Methods of Chemical Analysis,Himalaya Publications House, New Delhi, (1996).

OUTCOMES:

On completion of the course the student will be able to

- Select analytical instruments using various techniques and methods of analysis.
- Analyze different analyte by effectively using analytical instruments for industrial applications.

EIBY22 PROCESS MODELLING AND SIMULATION L T P C

3 0 0 3

OBJECTIVES:

- To have knowledge of the concepts of model and modelling in the field of chemical engineering.
- To have knowledge of the fundamentals of linear and non-linear optimisation, and acquire abilities to solve chemical process optimisation problems.
- To acquire abilities to propose and solve simple chemical process, unit operation and control system models in the chemical industry.
- To acquire ability to develop simple chemical process simulators using commercial software.

MODULE I INTRODUCTION 3

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

MODULE II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flowsheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

MODULE III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

MODULE IV STEADY STATE DISTRIBUTED SYSTEM 7

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

MODULE V UNSTEADY STATE DISTRIBUTED SYSTEM 11

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption,

plug flow reactor, hierarchy in model development, classification and solution of partial differential equations.

MODULE VI OTHER MODELLING APPROACHES 6

Empirical modeling, parameter estimation, population balance and stochastic modeling.

Total Hours: 45

REFERENCES:

1. Ramirez, W., "Computational Methods in Process Simulation", 2nd Edn., Butterworths, New York, 2000.
2. Luyben, W.L., "Process Modelling Simulation and Control", McGraw-Hill Book Co., 1973.
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", John Wiley, 2000.
4. Franks, R. G. E., "Mathematical Modelling in Chemical Engineering", John Wiley, 1967.

OUTCOMES:

On completion of this course, the students will be able to

- carry out the analysis, design, simulation and optimisation of processes and products.
- design, manage and operate chemical process simulation, control and instrumentation procedures.

EIBY23	MICROCONTROLLER BASED DIGITAL CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To equip the students with relevant knowledge about the functions of a central processing unit on a single integrated circuit (IC)
- To learn the basic concepts of computer based process control.

MODULE I MICROCONTROLLERS **9**

Basics of Microcontroller – Architecture – features – classification of PIC microcontroller – Instruction set – special function register – C-compiler for microcontroller – programming concept

MODULE II TEMPERATURE SENSORS **9**

Temperature measurement – Types of temperature sensor - study of temperature sensor – thermocouple – RTD, thermistor, practical microcontroller circuit for thermocouple, RTD, Thermistor, hardware design – Design concept

MODULE III DIGITAL CONTROL SYSTEM **9**

Digital control system – Introduction, Sampling – Quantization, using Z transform, inverse transform function – digital control algorithm – control of temperature using PID, Zeigler Nicholus algorithm.

MODULE IV STABILITY **9**

Open loop and close loop trans function model for I order and II order systems using Z transform, Stability and Introduction, Jury's stability test for a system, Root locus and Bode plot – frequency and analysis, Bang control of temperature, Closed loop tuning.

MODULE V DIGITAL CONTROLLER DESIGN **9**

Overview of temperature controller process, Mathematical modeling of tank, heater, RTD or thermistor or thermocouple – Programming and design of PI, PID controller using C. Assembling and testing of controller board for a temperature controller system.

Total hours : 45

REFERENCES:

1. Dogan Ibrahim, “Microprocessor based temperature monitoring and control”, Newnes Publication, 1st Edition, 2002.
2. Dogan Ibrahim, “Microcontroller based applied digital control”, Wiley Publication, 1st Edition, 2006.
3. M. Gopal, “Digital Control Engineering”, Newage International Pvt Ltd., Pulishers, 2nd Edition.

OUTCOMES:

On completion of this course, the students will have

- Adequate knowledge about functions of a microprocessor and microcontroller.
- Detailed knowledge on instructions used in microprocessor and microcontroller for the execution of program.
- Ability to review the concept of sampling and pulse transfer function.
- Ability to learn the design techniques for digital controllers.

EIBY24 COMPUTER NETWORKS L T P C

3 0 0 3

OBJECTIVES:

- To provide students with a theoretical and practical base in computer networks issues.
- To prepare students for easy transfer from academic into practical life in the field of computer network.

MODULE I COMPUTER COMMUNICATIONS ARCHITECTURE 9

Network topology; Switching: Circuit switching and packet switching; Datagrams and virtual circuits; ISO reference model for layered architecture; Functions of various layers.

MODULE II LOCAL AREA NETWORKS 9

Objectives and advantages of PC LANs; Topologies for LANs; Media for LANs; Medium access control techniques: CSMA, CSMA/CD, Token bus and token ring; Performance analysis for LANs.

MODULE III INTERNETWORKING 9

Basic principles; Bridges and routers; Connection oriented and connectionless internetworking. Introduction to the protocols in the TCP/IP protocol suite.

MODULE IV SECURITY AND AUTHENTICATION TECHNIQUES 9

ISDN and B – ISDN Frame relay and asynchronous transfer mode (ATM). Data compression. Data security and authentication techniques.

MODULE V APPLICATIONS 9

Electronic mail, Network security, other internet applications. Test techniques for data networks: Basic tests; transmission impairment measurement tests; Time domain reflectometry (TDR). Line monitors and protocol analyzers.

Total Hours : 45

REFERENCES:

1. Stalling W, Data and Computer Communications, Fifth edition, Prentice Hall of India, New Delhi, 1997.
2. William Stallings, High-speed Networks-TCP/IP and ATM Design Principles, Prentice Hall International Edition, New Jersey, 1998.
3. Ed Taylor, McGraw -Hill Internetworking Handbook, Second edition, McGraw Hill Company Inc., New York, 1998.
4. Bertsekas D and Gallager. R, Data Networks, Second edition, Prentice Hall of India, New Delhi, 1992.

OUTCOMES:

On completion of this course, the students will have

- Ability to apply knowledge of mathematics, probability, and statistics to model and analyze some networking protocols.
- Ability to design, implement and analyze simple computer networks.
- Ability to identify, formulates, and solve network engineering problems.
- Knowledge of contemporary issues in computer networks.
- Ability to use techniques, skills, and modern networking tools necessary for engineering practice.

EIBY31 VIRTUAL INSTRUMENTATION L T P C

3 0 0 3

OBJECTIVES:

- To expertise the students in the field of Virtual Instrumentation Systems
- To deal with the programming of VI using LabVIEW software

MODULE I INTRODUCTION 9

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

MODULE II VI PROGRAMMING TECHNIQUES 9

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

MODULE III DATA ACQUISITION 9

Introduction to data acquisition on PC, Sampling fundamentals, Input / Output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements – Issues involved in selection of Data acquisition cards – Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

MODULE IV VI TOOLSETS 9

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

MODULE V VI APPLICATIONS **9**

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total Hours: 45

REFERENCES:

1. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
2. Lisa K. wells & Jeffrey Travis, Lab VIEW for everyone, Prentice Hall, New Jersey, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

OUTCOME:

- Student will be able to use the PC to mimic real instruments with their dedicated controls and displays with the added versatility that come with LabVIEW software.

EIBY32 APPLIED PROGRAMMABLE LOGIC CONTROL AND DISTRIBUTED CONTROL SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES

- To provide indepth knowledge in PLC and its programming
- To train the students to take up industrial applications and solve it using PLC
- To provide basic knowledge in the architecture and local control unit of distributed control system
- To give adequate knowledge in the interfaces used in DCS

MODULE I COMPUTER CONTROLLED SYSTEMS 9

Role of computers in Industrial control, Basic building blocks of computer control of processes, Sampling considerations, linearization, characteristics of digital data, digital controller modes: Position form and velocity form, deadbeat control, Dahlin's algorithm, Alarms, Data loggers, Data acquisition system, Direct digital control (DDC), Supervisory control and Data acquisition systems (SCADA).

MODULE II PROGRAMMABLE LOGIC CONTROLLER: HARDWARE AND BASIC OPERATIONS 9

Hard relay logic, Evolution of Programmable logic controller (PLC), Hardware Components of PLC: Input/Output modules, power supplies, isolators, CPU, memory and programming devices. General PLC programming procedures, Developing fundamental ladder logic programs (as per IEC61131) for Boolean operations, PLC basic functions : Register basics, timer functions, counter functions.

MODULE III PROGRAMMABLE LOGIC CONTROLLERS : ADVANCED OPERATIONS, INSTALLATIONS AND TROUBLESHOOTING9

Developing program control instructions, data manipulation instructions, math instructions, sequencer and shift register instructions, Functional block diagram, Analog control using PLC (PID control configuration, PLC installations and troubleshooting

MODULE IV DISTRIBUTED CONTROL SYSTEM 9

Introduction to Distributed control system, DCS architectures, Comparison, Local Control Unit, Process interfacing issues, Operator interfaces - Low level and high level operator interfaces - Operator displays - Engineering interfaces - Low level and high level engineering interfaces, Latest trends and development, DCS support to Enterprise resources planning (ERP), performance criteria for DCS and other automation tools.

MODULE V COMMUNICATIONS IN DCS 9

Introduction - Evolution of signal standard - HART communication protocol - communication modes - HART networks - HART commands - HART field controller implementation - HART and OSI model - Field bus - Introduction Profibus, Modbus - Foundation field bus - General field bus architecture - basic requirement - basic requirements of field bus standard - field bus topology. Introduction to AS-Interface (As-i), Device net and Industrial Ethernet.

Total Hours: 45

OUTCOMES

At the end of the course, the student will have a thorough knowledge on PLC, DCS and the communications used in Industrial applications. In addition, he/she will be in a position to solve real world industrial problems.

TEXT BOOKS:

1. Petrezeulla, Programmable Controllers, Mc-Graw Hill, 1989.
2. Michael P.Lucas, Distributed Control System, Van Nastrand Reinhold Company, New York,1986.
3. Romilly Bowden, HART application Guide, HART Communication Foundation, 1999.
4. Berge, J., “Field Buses for Process Control: Engineering, Operation, and Maintenance”, ISA Press, 2004.

REFERENCES:

1. A.S.Tanenbaum, Computer Networks, Third Edition, Prentice Hall of India, 1996.

2. G.K.Mc-Millan, Process/Industrial Instrument and controls and handbook, Mc Graw Hill, New York, 1999.

3. Lucas, M.P., Distributed Control System, Van Nastrand Reinhold Company, New York, 1986.

4. Hughes T, Programmable Logic Controllers, ISA Press, 1989.

5. W. Bolton, “PLC”, Elsevier Newnes

6. John W. Webb Ronald & Areis “PLC”

7. Clarke, G., Reynders, D. and Wright, E., “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newnes, 1st Edition, 2004.

8. Mackay, S., Wrijut, E., Reynders, D. and Park, J., “Practical Industrial Data Networks Design, Installation and Troubleshooting”, Newnes Publication, Elsevier, 1st Edition, 2004.

EIBY33	PROCESS OPTIMIZATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Students will be able to understand the basic concepts of process optimization and corresponding methodologies linear program, nonlinear program, and Newton's method, optimization of unconstrained functions, unconstrained multivariable optimization and Applications of optimization in chemical processes.

MODULE I INTRODUCTION **5**

Problem formulation, degree of freedom analysis, objective functions, constraints and feasible region, Types of optimization problem.

MODULE II LINEAR PROGRAMMING **10**

Simplex method, Barrier method, sensitivity analysis, Examples.

MODULE III NONLINEAR UNCONSTRAINED OPTIMIZATION **10**

Convex and concave functions unconstrained NLP, Newton's method Quasi-Newton's method, Examples.

MODULE IV CONSTRAINED OPTIMIZATION **10**

Direct substitution, Quadratic programming, Penalty Barrier Augmented Lagrangian Methods.

MODULE V MULTI OBJECTIVE OPTIMIZATION **10**

Weighted Sum of Squares method, Epsilon constrain method, Goal attainment Examples. Introduction to optimal control and dynamic optimization.

Total Hours : 45

REFERENCES:

1. Edgar, T. F., Himmelblau, D. M. and Ladson, L. S., "Optimization of Chemical Processes", 2nd Ed., McGraw Hill, New York, 2003.
2. Diwaker, U. W. "Introduction to Applied Optimization", Kluwer, 2003.

3. Joshi, M.C. and Moudgalya, K. M., “Optimization, Theory and Practice”, Narosa, New Delhi, 2004.

4. Rao, S.S., Engineering Optimization: Theory and Practice, New Age Publishers, 2000.

OUTCOMES:

The student will be able to

- use the basic concepts of process optimization and corresponding methodologies
- solve constrained and unconstrained optimization problems using linear programming, nonlinear programming and Newton’s method, functions.

EIBY34 ADVANCED VLSI SYSTEM DESIGN L T P C

3 0 0 3

OBJECTIVE

- To provide knowledge on design methodologies , CMOS circuit scaling, advanced logic circuit styles, noise sources and signal integrity in digital design, design techniques for dynamic and static power reduction, power supply issues, interconnect analysis, clocking and synchronization, process variation, and performance verification.

MODULE I BASIC DEVICE CHARACTERISTICS 9

NMOS, PMOS and CMOS devices characteristics, linear, saturation modes, bulk effect capacitances, device models for simulation, CMOS device fabrication principles.

MODULE II BASIC CIRCUITS FOR DIGITAL SYSTEMS 9

CMOS Inverter Design principles — Design layout rules. Construction of multiplexers, transmission gates, latches, flip flops. Timing and fan-out considerations.

MODULE III BUILDING BLOCKS OF DIGITAL SYSTEMS 9

Combinational logic and sequential logic circuits, Data path circuits, Adder multiplier architecture and accumulators.

MODULE IV PROGRAMMABLE LOGIC DEVICES AND FPGAs 9

Programmable Logic interconnect principles and types, Programmable logic elements and AND-OR arrays, Routing Procedures in FPGAs and CPLDs, Programming methods for FPGAs and CPLDs, Comparison of ACTEL, Altera and Xlinx FPGAS.

MODULE V PRINCIPLES OF HDL 9

Introduction to VHDL-Sequential and concurrent descriptions. Signal, Port and variable statements. Wait, case and other sequential statements. Block, process, component and generate descriptions. Test bench creation and principles of operation of VHDL simulator. Introduction to verilog and brief comparison with VHDL.

Total Hours: 45

REFERENCES:

1. Smith, M., Application specific Integrated Circuits, Addision Wesley Press, 1999.
2. Rabey, J.M., Digital Integrated Circuits: A design Perspective, Prentice Hall, 1995.
3. Weste, N.H.E and Ershingian, K., Principles of CMOS VLSI Design: A Design Perspective, Addison Wesley, 1996.
4. Bhasker,J., VHDL Primer, Prentice Hall 1995.

OUTCOMES:

The student will be able to

- Learn and participate in the process of modern VLSI design, verification, and test.
- Develop an understanding for the advanced design concepts in modern VLSI technologies.

EIBY35 WIRELESS SENSOR NETWORKS L T P C

3 0 0 3

OBJECTIVES:

- To introduce the basic concepts and applications of wireless sensor networks
- To provide the students insight of fundamental wireless communication knowledge used in wireless sensing network
- To study the relevant protocols and design issues of wireless sensor network

MODULE I INTRODUCTION 9

Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture – Hardware components, energy consumption of sensor nodes, Network architecture – Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, design principles, Development of wireless sensor networks.

MODULE II PHYSICAL LAYER 9

Introduction, wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication , packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, Energy usage profile, choice of modulation, Power Management.

MODULE III DATA LINK LAYER 9

MAC protocols –fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols –fundamentals task and requirements, error control, framing, link management.

MODULE IV NETWORK LAYER 9

Gossiping and agent-based uni-cast forwarding, Energy-efficient unicast, Broadcast and multicast, geographic routing, mobile nodes, Data centric and

content based networking –Data centric routing, Data aggregation, Data centric storage, Higher layer design issue

MODULE V CASE STUDY **9**

Target detection tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Sensor Network Platforms and tools-Sensor node hardware, Node-level software platforms, node –level simulators.

Total Hours: 45

REFERENCES:

1. Wireless Sensor Networks: an information processing approach – Feng zhao, Leonidas guibas, Elsevier publication, 2004.
2. Wireless Sensor Networks –C.S.Raghavendra Krishna, M.Sivalingam and Tarib znati, Springer publication, 2004.
3. Wireless Sensor Networks : Architecture and protocol –Edgar H .Callaway, CRC, 2005.
4. Protocol and Architecture for Wireless Sensor Networks –Holger Karl, Andreas willig John wile y publication, Jan 2006.
5. Wireless Sensor Networks: First European workshop, EWSN 2004, Berlion, germany, proceedings –Holger Karl, Andreas willig, Adam holisz, Springer publication, January 2004.
6. I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, “Wireless sensor networks: a survey”, computer networks, Elsevier, 394 - 422, 2002.
7. Jamal N. Al-karaki, Ahmed E. Kamal, “Routing Techniques in Wireless sensor networks: A survey”, IEEE wireless communication, 6 – 28, December 2004.

OUTCOMES:

The students will have the

- Ability to apply knowledge of mathematics, science and engineering.
- Ability to design a system, component or process to meet desired needs.
- Ability to identify, formulate and solve engineering problems.

ELECTIVE – IV

EIBY41	**OPTIMAL CONTROL**	**L T P C**
		3 0 0 3

OBJECTIVES:

- To determine the control signals that will cause a controlled system to satisfy the physical constraints and, at the same time, minimize (or maximize) some performance criterion.
- To provide students with a firm foundation in optimality principles in modern control systems design.
- To study fundamental concepts of optimal control including the Hamiltonian, Long range/Euler equations, the Riccati equation, dynamic programming, Pontryagin's minimum principle, Bellman's equation, and reinforcement learning.
- To show how to apply optimal principles in the design of feedback controllers for practical systems.
- To provide design experience and insight for optimal control system design using MATLAB simulations.

MODULE I INTRODUCTION **7**

Introduction: Statement of optimal control problem – Problem formulation and forms of optimal control – Selection of performance measures- Necessary conditions for optimal control – Pontryagin's minimum principle – State inequality constraints – Minimum time problem.

MODULE II NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL **8**

Numerical Techniques for Optimal Control: Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method solution of Ricatti equation by negative exponential and interactive methods.

MODULE III LQ CONTROL PROBLEMS AND DYNAMIC PROGRAMMING **8**

LQ Control Problems and Dynamic Programming : Linear optimal regulator problem – Matrix Riccatti equation and solution method – Choice of weighting matrices – Steady state properties of optimal regulator – Linear tracking

problem – LQG problem – Computational procedure for solving optimal control problems – Characteristics of dynamic programming solution – Dynamic programming application to discrete and continuous systems – Hamilton Jacobi Bellman equation.

MODULE IV FILTERING AND ESTIMATION 7

Filtering and Estimation: Filtering – Linear system and estimation – System noise smoothing and prediction – Gauss Markov discrete time model – Estimation criteria – Minimum variance estimation – Least square estimation – Recursive estimation.

MODULE V KALMAN FILTER AND PROPERTIES 7

Kalman Filter and Properties: Filter problem and properties – Linear estimator property of Kalman Filter – Time invariance and asymptotic stability of filters – Time filtered estimates and signal to noise ratio improvement – Extended Kalman filter – Case study: Boiler optimization and control.

MODULE VI ROBUST CONTROL SYSTEM 8

Robust control system and system sensitivity, analysis of robustness, systems with uncertain parameters. Types of uncertainties: additive and multiplicative with examples. Design of robust control systems using worse case polynomial and Routh-Hurwitz criteria.

Total Hours : 45

REFERENCES:

1. D. Kirk, “Optimal Control -An Introduction”, Prentice Hall, Inc., Englewood Cliff, N.J., 1970.
2. M. Gopal,” Modern Control System Theory”, Wiley Eastern, 1982.
3. Anderson B. D. O. and J. B. Moore, “Linear Optimal Control”, Prentice Hall, Englewood Cliff, N.J., 1971.
4. B.D.O. Anderson and J.B. Moore, “Optimal Control: Linear Quadratic Methods“, Prentice-Hall, 1990.
5. R.C. Dorf, R.H. Bishop, "Modern Control Systems", 8th Edition, Addison Wesley, 1999.

6. Ben M. Chen, " Robust and H_∞ Control ", Springer Verlag, 2000.

7. S. P. Bhattacharya, H. Chapellat, "Robust Control - The Parametric Approach", Prentice Hall,1995.

8. Petros A. Ioannou, Jing Sun, "Robust Adaptive Control", Prentice Hall.1995.

OUTCOMES:

The student will be able to

- Investigate how dynamical systems should be controlled in the best possible way.
- Integrate the tools learnt during the course and apply them to more complex problems.
- Combine the mathematical methods used in optimal control to derive the solution to variations of the problems studied in the course.

EIBY42	COMPUTER AIDED DESIGN OF INSTRUMENTATION SYSTEMS	L T P C 3 0 0 3

OBJECTIVE:

- Students will be able to enter into and advance their careers in the analysis, applied design, development, implementation and management of physical systems and processes.

MODULE I DATA ACQUISITION AND INSTRUMENT INTERFACE 9

Programming and simulation of Building block of instrument Automation system – Signal analysis, I/O port configuration with instrument bus protocols - ADC, DAC, DIO, counters & timers, PC hardware structure, timing, interrupts, DMA, software and hardware installation, current loop, RS 232/RS485, GPIB, USB protocols.

MODULE II VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES 9

Block diagram and architecture of a virtual instrument, Graphical programming in data flow, comparison with conventional programming, Vis and sub-Vis, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

MODULE III DESIGN TEST & ANALYSIS 9

Spectral estimation using Fourier Transform, power spectrum, correlation methods, Stability analysis, Fault analysis –Sampling, Data Parity and error coding checks, Synchronization testing – Watch dog timer, DMA method – Real-time Clocking, Noise- Gaussian, White analysis.

MODULE IV PC BASED INSTRUMENTATION 9

Introduction – Evolution of signal standard – HART Communication protocol – Communication modes – HART networks – control system interface – HART commands – HART field controller implementation – HART and the OSI model.

MODULE V SIMULATION OF PHYSICAL SYSTEMS 9

Simulation of linear & Non-linear models of systems, Hardware in loop simulation of physical systems using special softwares.

Total Hours: 45

REFERENCES:

1. K. Ogatta, “Modern control Engineering”, Fourth edition, Perason education 2002.
2. Dorf and Bishop, “Modern Control Engineering”, Addison Weseley, 1998.
3. Patrick H. Garrett, “High performance Instrumentation and Automation”, CRC Press, Taylor & Francis Group, 2005.

OUTCOMES:

The students are expected to possess knowledge and achieve skills on the following:

- An ability to identify, analyze, and solve broadly-defined engineering technology problems.
- An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities.
- An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies.

EIBY43	BIOSIGNAL PROCESSING	L	T	P	C
	Prerequisite : Digital Signal Processing, Biomedical Instrumentation	3	0	0	3

OBJECTIVES:

- To provide an acquaintance of the physiology, nature of complexities and equipment safety.
- To introduce the student to the various modeling and simulation of biomedical instrumentation.
- To classify biosignals and their acquisition, analysis using wavelets
- To provide latest knowledge of medical assistance / techniques and therapeutic equipments.

MODULE I INTRODUCTION TO BSP **8**

Sources of Biomedical signals, types of signals - Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT FFT algorithm - Digital filters - Introduction to FIR and IIR filter.

MODULE II CLASSICAL SPECTRAL ESTIMATION TECHNIQUES **8**

Periodogram, Blackman - Tukey spectral Estimation applications - analysis ofthe Doppler signal using the Periodogram, analysis of Auditory Evoked potentials (AEP) using periodogram, analysis of Heart rate variability using the periodogram cepstrum anlaysis - Cepstra, power cepstrum, applications of cepstrum analysis - analysis of the ECG signal using cepstrum technique, analysis of Diastolic Heart sound using cepstrum technique.

MODULE III ADAPTIVE NOISE CANCELLATION **8**

Introduction, principle of adaptive noise canceling, adaptive Noise cancellation with the LMS and RLS adaptation algorithm - applications - adaptive noise canceling method to enhance ECG monitoring, adaptive noise canceling method to enhance Fetal ECG monitoring, adaptive noise canceling method to enhance Electro gastric measurements.

MODULE IV PARAMETRIC MODELING METHODS **8**

Autoregressive (AR) methods - Linear Prediction and Autoregressive methods, the autocorrelation (Yule - walker) methods, applications of AR methods AR

modeling of seizure EEG, ECG signals and surface EMG. Autoregressive Moving Average (ARMA) method - MLE method, Akaike method, Durbin method, applications - ARMA modeling of somatosensory Evoked Potentials (SEPs), Diastolic Heart sounds and cutaneous Electro gastric signals.

MODULE V NON LINEAR BIOSIGNAL PROCESSING AND WAVELET TRANSFORM 8

Clustering methods - hard and fuzzy clustering, applications of Fuzzy clustering to Biomedical signal processing, Neural Networks - Introduction - NN in processing and analysis of Biomedical signals, wavelet transform - Introduction, Filter bank implementation of discrete wavelet transform, signal Denoising using wavelet transform, wavelet based compression.

MODULE VI CASE STUDY 5

Problem statement: Connect up to 8/16 ECG input leads with ECG system or get available ECG data. Use automated analysis features for HRV, to classify heartbeats, identify arrhythmias, perform ECG averaging and report.

Total Hours: 45

REFERENCES:

1. M.Akay, 'Biomedical Signal Processing' Academic Press, San Diego, 1994.
2. M.Akay, Nonlinear Biomedical Signal Processing, Fuzzy Logic, Neural Networks and New Algorithms (vol1) (IEEE Press series on Biomedical Engineering)
3. Eugene.N. Bruce, 'Biomedical Signal Processing and Signal Modeling', Wiley publications 2000.
4. Rangaraj M. Rangayan, Biomedical signal analysis , John Wiley and sons (ASIA) Pvt Ltd., 2009.

OUTCOMES:

- Students will have an exposure various modeling and simulation of biomedical instrumentation.
- They will be able to analyze typical waveforms of bio potentials
- They will show their enhanced knowledge on Imaging and will be able provide safety during measurement.
- The students will have the ability to acquire, analyse and identify the abnormalities in biosignals.

EIBY44	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To learn the fundamentals of digital image processing techniques.

MODULE I DIGITAL IMAGE FUNDAMENTALS **9**

Elements of digital image processing systems, Elements of visual perception, psycho visual model, brightness, contrast, hue, saturation, mach band effect, Color image fundamentals -RGB, HSI models, Image sampling, Quantization, dither, Two-dimensional mathematical preliminaries.

MODULE II IMAGE TRANSFORMS **9**

1D DFT, 2D transforms – DFT, DCT, Discrete Sine, Walsh, Hadamard, Slant, Haar, KLT, SVD, Wavelet Transform.

MODULE III IMAGE ENHANCEMENT AND RESTORATION **9**

Histogram modification and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic and Yp mean filters, Homomorphic filtering, Color image enhancement. Image Restoration – degradation model, Unconstrained and Constrained restoration, Inverse filtering – removal of blur caused by uniform linear motion, Wiener filtering, Geometric transformations – spatial transformations, Gray-Level interpolation.

MODULE IV IMAGE SEGMENTATION AND RECOGNITION **9**

Edge detection. Image segmentation by region growing, region splitting and merging, edge linking. Image Recognition – Patterns and pattern classes, Matching by minimum distance classifier, Matching by correlation, Back Propagation Neural Network, Neural Network applications in Image Processing.

MODULE V IMAGE COMPRESSION **9**

Need for data compression, Huffman. Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Block Truncation Coding. Transform Coding – DCT and Wavelet. JPEG , MPEG. Standards, Concepts of Context based Compression.

Total Hours: 45

REFERENCES:

1. Rafael C. Gonzalez, Richard E.Woods, 'Digital Image Processing', Pearson Education, Inc., Second Edition, 2004.
2. Anil K. Jain, 'Fundamentals of Digital Image Processing', Prentice Hall of India, 2002.
3. David Salomon : Data Compression – The Complete Reference, Springer Verlag New York Inc., 2nd Edition, 2001
4. Rafael C. Gonzalez, Richard E.Woods, Steven Eddins, ' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.
5. William K.Pratt, ' Digital Image Processing', John Wiley, NewYork, 2002.
6. Milman Sonka, Vaclav Hlavac, Roger Boyle, 'Image Processing, Analysis, and Machine Vision', Brooks/Cole, Vikas Publishing House, II ed., 1999.
7. Sid Ahmed, M.A., 'Image Processing Theory, Algorithms and Architectures', McGrawHill, 1995.

OUTCOMES:

On completion of this course, the students will be able

- To understand the basic concept of image processing.
- To learn the Image enhancement techniques.
- To understand the theory of Image Morphology, Segmentation.
- To analyze the methods of image Representation, Description and Recognition.

ELECTIVE – V

EIBY51	ROBUST CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To Introduction the modern robust control theory techniques for large-scale uncertain multivariable systems: stability and performance; computer-aided tools for both system analysis and controller design.
- To get an idea about the multivariable robust control, including H2 and H-infinity optimal control and robust performance analysis and synthesis against structured uncertainty.

MODULE I INTRODUCTION 9

Introduction-measure of robustness –robustness in stability and performance-plant uncertainty model- robustness of sampled-data control system.

MODULE II ANALYSIS OF ROBUSTNESS 9

Analysis of robustness-stability analysis –gamma stability-testing sets – Kharitonov's theorem –stability radius.$_{\infty}$

MODULE III ROBUST CONTROL SYSTEM DEISGN 9

Design of robust control system –root locus method-frequency response method-ITAE method –robust IMC system –Pseudo-quantitative feedback theory based robust controller.

MODULE IV H CONTROL 9

Robust control design using H methods – H control for linear and non-linear systems.

MODULE V APPLICATIONS 9

Robust control for constrained systems –integral quadratic constraints and weighted quadratic constraints for linear systems – non-linear system with constraints –case study.

Total Hours: 45

REFERENCES:

1. S.P.Bhattacharyya, H.Chapellat and L.H.Keel, Robust Control (The Parametric approach), Prentice Hall, New Jersy, 1995.
2. J.Ackerman, Robust control systems with uncertain physical parameters, Springer –Verlag, London, 1993.
3. L.R.Petersen, V.A.Ugrinovskii and A.V.Savkin, Robust control design using h8 methods, Springer –London, 1993.
4. R.C.Dorf and R.H.Bishop, Modern Control Systems, Addison- Wesley, Delhi, 1999.

OUTCOMES:

- Students will familiarize in the basics of robust control.
- Students will be able to mimi to the concept of Robust Control System Design using MATLAB.

EIBY52 DIGITAL INSTRUMENTATION L T P C

3 0 0 3

OBJECTIVES:

- To introduce the basics concepts of digital techniques and digital instrumentation.
- To learn the various digital methods of measurement.
- To discuss the digital display and recording devices.
- To understand the concept of digital signal analysis.
- To discuss the current trends in digital instrumentation.

MODULE I DATA ACQUISITION SYSTEMS 9

Overview of A/D converter, types and characteristics – Sampling , Errors. Objective – Building blocks of Automation systems –Counters – Modes of operation- Frequency, Period, Time interval measurements, Prescaler, Heterodyne converter for frequency measurement, Single and Multi channel Data Acquisition systems.

MODULE II INTERFACING AND DATA TRANSMISSION 9

Data transmission systems – 8086 Microprocessor based system design – Peripheral Interfaces – Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications.

MODULE III INSTRUMENTATION BUS 9

Introduction, Modem standards, Basic requirements of Instrument Bus standards, Bus communication, interrupt and data handshaking, Interoperability, interchangeability for RS-232, USB, RS-422, RS-485.

MODULE IV PARALLEL PORT BUSES 9

Field bus, Mod bus, GPIB, IEEE-488, VME, VXI, Network buses – Ethernet – TCP/IP protocols; CAN bus- basics, Message transfer, Fault confinement.

MODULE V CASE STUDIES **9**

PC based DAS, Data loggers, PC based industrial process measurements like flow, temperature, pressure and level development system, CRT interface and controller with monochrome and colour video display.

Total Hours: 45

REFERENCES:

1. A.J. Bouwens, “Digital Instrumentation” , TATA McGraw-Hill Edition, 1998.
2. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice-Hall India, 2005.
3. H S Kalsi, “Electronic Instrumentation” Second Edition, Tata McGraw-Hill, 2006.
4. Joseph J. Carr, “Elements of Electronic Instrumentation and Measurement” Third Edition, Pearson Education, 2003.
5. Buchanan, “Computer busses”, Arnold, London,2000.
6. Jonathan W Valvano, “Embedded Microcomputer systems”, Asia Pvt. Ltd., Brooks/Cole, Thomson, 2001.

OUTCOME:

- Students will have the ability select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities.

EIBY53 APPLICATIONS OF MEMS TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES

- This course will obtain a basic understanding of the operation principles of MEMS Devices and the various micromachining techniques used to fabricate MEMS devices.
- To provide knowledge about the Electrostatic, Thermal and piezoelectric sensors.
- To become familiar with a wide variety of MEMS application areas such as Micro fluids, Optical MEMS and medical.

MODULE I MEMS: MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS 9

Overview of micro fabrication – Silicon and other material based fabrication processes –Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

MODULE II ELECTROSTATIC SENSORS AND ACTUATION 9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

MODULE III THERMAL SENSING AND ACTUATION 9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

MODULE IV PIEZOELECTRIC SENSING AND ACTUATION 9

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.

MODULE V CASE STUDIES 9

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.

Total Hours: 45

REFERENCES:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2. Marc Madou, “Fundamentals of microfabrication”, CRC Press, 1997.
3. Boston, “Micromachined Transducers Sourcebook”, WCB McGraw Hill, 1998.
4. M.H.Bao “Micromechanical transducers : Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 2000.

OUTCOMES:

- Students will be able to know about operation principles of MEMS Devices and the various micromachining techniques used to fabricate MEMS devices.
- Students will be able to know about the MEMS application areas such as Micro fluids, Optical MEMS and medical.

EIBY54 PHYSIOLOGICAL CONTROL SYSTEMS L T P C

(Prerequisite: Biomedical Instrumentation, Control System) 3 0 0 3

OBJECTIVES:

The students will learn

- How to apply knowledge of mathematics, physics, biology and engineering to analyze physiological systems and evaluate the results,
- How to use computational tools to understand living systems,
- How to seek out and integrate relevant information from multiple sources when Faced with an unfamiliar problem.

MODULE I INTRODUCTION PHYSIOLOGICAL CONTROL SYSTEMS 6

Introduction to Human Physiology - Analysis of Physiological Control Systems - Difference between engineering and physiological control systems.

MODULE II STATIC ANALYSIS OF PHYSIOLOGICAL SYSTEMS 8

Open loop and Closed loop systems- Steady state analysis- Regulation of Cardiac Output- Regulation of Glucose- Chemical regulation of ventilation sytem.

MODULE III TIME FREQUENCY DOMAIN ANALYSIS OF LINEAR PHYSIOLOGICAL CONTROL SYSTEMS 8

Linearized respiratory mechanics- Open loop and Closed loop transient responses- First order and second order models- Impulse and Step response descriptors- Open and closed loop dynamics- Steady state responses to sinusoidal inputs- Graphical representations of frequency response- Frequency response of Glucose- Insulin regulation and Circulatory Control Model.

MODULE IV NON-LINEAR ANALYSIS OF PHYSIOLOGICAL CONTROL SYSTEMS 8

Difference between linear and non-linear systems- The Hodgkin-Huxley model and The Bonhoeffer- van der Pol model of Neuronal dynamics - Spontaneous Variability- Delayed feedback Nonlinear Control systems- Coupled non-linear Oscillators- Time varying Physiological closed loop systems- Sleep Apnea model.

MODULE V SIMULATION OF PHYSIOLOGICAL SYSTEMS 8

Simulation of cardiovascular variability (stroke volume constant and stroke volume variable)- Simulation of glucose- insulin regulation (Stolwijk and Hardy model) Simulation of neuromuscular reflex model -Simulation of patient-ventilator system- Simulation of respiratory sinus arrhythmia (Saul model).

MODULE VI IDENTIFICATION OF PHYSIOLOGICAL CONTROL SYSTEMS 7

Basic problems in physiological system analysis – non-parametric and parametric system identification methods – Identification of closed loop systems: The startling heart lung preparation – Kao's cross circulation experiment – minimal model of blood glucose regulation.

Total Hours: 45

REFERENCES:

I. Michael. C. K. Kho, Physiological Control Systems, IEEE Press, Ed., Robert. S. Herrick, Prentice — Hall of India, New Delhi, 2001.

2. Milhorn, H. T., The Application of Control theory to Physiological Systems, Saunders, W. B., Philadelphia, 1996.

3. Kuo, B. C., Automatic Control Systems, 4th ed., Prentice- Hall, Englewood Cliffs, NJ, 1994.

4. Dorf, R. C. and Bishop, R. H., Modern Control Systems, 7th ed., Addison-Wesley Reading, MA, 1995.

5. Thompson, J. M. T. and Stewart, H. B., Nonlinear dynamics and chaos, Wiley, New York, 1986.

OUTCOMES:

- Students will be able to explain the need for modeling in biomedical science and medicine.
- Students will be able to describe the considerations for developing predictive models at multiple scales to answer specific physiological questions.
- Students will be able to apply mathematical descriptions to analyze physiological systems.
- Students will be able to explain how to interpret the results of modeling in the context of normal and abnormal physiology.

ELECTIVE – VI

EIBY61	**BIO-MEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To provide the basic knowledge on the operation principles of MEMS Devices.
- To provide knowledge about the micro opto electro mechanical system,micro fluidic system and micro sensors.

MODULE I MEMS AND MICROSYSTEMS **9**

Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modeling and properties of materials.

MODULE II MICROSENSORS AND ACUATORS **9**

Mechanical sensors and actuators – beam and cantilever, piezoelectric materials, thermal sensors and actuators- micromachined thermocouple probe, Peltier effect heat pumps, thermal flow sensors, Magnetic sensors and actuators- Magnetic Materials for MEMS, Devices.

MODULE III MICRO OPTO ELECTRO MECHANICAL SYSTEMS **9**

Fundamental principle of MOEMS technology, light modulators, beam splitter, microlens, digital micro mirror devices, light detectors, optical switch

MODULE IV MICROFLUIDIC SYSTEMS **9**

Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system.

MODULE V BIO MEMS **9**

Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA hybridization, Electronic nose, Bio chip.

Total Hours: 45

REFERENCES:

1. Tai Ran Hsu , " MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002.
2. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007.
3. Wanjun Wang, Steven A.Soper " BioMEMS- Technologies and applications", CRC Press,Boca Raton, 2007.

OUTCOMES:

- Students will be able to know about operation principles of MEMS Devices .
- Students will be able to know about the MEMS application areas such as micro opto electro mechanical system, micro fluidic system and micro sensors.

EIBY62	MULTIVARIABLE CONTROL	L	T	P	C
	(Prerequisite: Process Control, System theory)	3	0	0	3

OBJECTIVE:

- To design a controller considering all interactions in a plant both in terms of performance and closed-loop stability.

MODULE I INTRODUCTION TO MULTIVARIABLE CONTROL 9

Review of SISO and TITO systems – Introduction to multivariable control – Transfer functions for MIMO systems – frequency response analysis – Control of multivariable plants - RHP zeros – Condition number and RGA. Introduction to MIMO robustness – General control problem formulation.

MODULE II ELEMENTS OF LINEAR SYSTEM THEORY 9

System Descriptions – State controllability and state observability – stability, poles and zeros. Internal Stability of feedback systems – stabilizing controllers – stability analysis in the frequency domain.

MODULE III CONTROLLER DESIGN 9

MIMO feedback design – LQG control – H2 and H8 control - H8 loop shaping design.

MODULE IV CONTROL STRUCTURE DESIGN AND MODEL REDUCTION 9

Optimization and control – RGA for non square plant – control configuration elements – decentralized feedback control. Model reduction: Balanced truncation and balanced residualization – optimal Hankel norm approximation – model reduction using MATLAB.

MODULE V CASE STUDY 9

Helicopter control – Aero engine control – Distillation process

Total Hours: 45

REFERENCES:

1. S. Skosgestad and I. Postlethwaite, Multivariable Feedback Control: Analysis and Design, John Wiley & Sons, 1996.

2. T. Glad and L. Ljung, Control Theory: Multivariable & Nonlinear Methods, Taylor & Francis, 2000.

3. B.D.O. Anderson and J.B. Moore, Optimal Control: Linear Quadratic Methods, Prentice-Hall, 1990.

4. Donald E. Kirk, Optimal Control Theory: An Introduction, Prentice Hall, 1970.

5. S.P. Sage and C.C. White III, Optimum System Control, 2nd ed. Prentice-Hall, 1977.

6. R. Stengel, Optimal Control and Estimation, Dover Press, 1994.

OUTCOME:

- Students can design a controller considering all interactions in a plant both in terms of performance and closed-loop stability using MATLAB.

EIBY63 APPLIED SOFT COMPUTING FOR PROCESS CONTROL AND MODELING, OPTIMIZATION

L	T	P	C
3	0	0	3

OBJECTIVE:

Introduce students to soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world problems.

MODULE I REVIEW OF NEURAL NETWORK AND FUZZY LOGIC 10

Biological Neuron - Artificial neuron — Activation functions — Network Architecture — Learning Process — Single Layer Perception — Limitations — Multi Layer Perception — Back propagation algorithm — RNN — Reinforcement learning — Discrete time hop field networks RBF — ART, SVM, Fuzzy set theory — Fuzzy sets — Operation on Fuzzy sets — Fuzzy relations — Fuzzy membership functions — Fuzzy conditional statements — Fuzzy rules – MAMDANI – TAKAGI SUGENO.

MODULE II NEURAL NETWORKS FOR MODELING AND CONTROL 8

Modeling of non linear systems using ANN- NARX,NNSS,NARMAX - Generation of training data - Model validation- Control of non linear system using ANN- Adaptive neuro controller – Case study - Familiarization of Neural Network Control Tool Box

MODULE III FUZZY LOGIC FOR MODELING AND CONTROL 9

Modeling of non linear systems using fuzzy models(Mamdani and Sugeno) – TSK model - Fuzzy Logic controller – Adaptive fuzzy systems- Gain scheduling using Fuzzy Logic - Case study - Familiarization of Fuzzy Logic Tool Box.

MODULE IV HYBRID CONTROL SCHEMES 9

Fuzzy Neuron — Fuzzification and rule base Using ANN — Introduction to Evolutionary Algorithm — Optimization of membership function and rule base using Genetic Algorithm — Particle Swarm Optimization – Ant colony optimization.

MODULE V OPTIMAL IDENTIFICATION AND PARAMETER OPTIMIZATION USING EVOLUTIONARY AND SWARM INTELLIGENCE TECHNIQUES **9**

Process identification, PID controller parameter optimization, State feedback controller parameter optimization of process loops using evolutionary optimization techniques and swarm intelligence technique

Total Hours: 45

TEXT BOOKS:

1. Laurence Fausett, Fundamentals of Neural Networks, Prentice Hall, Englewood cliffs, N.J., 1992.
2. Jacek M.Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, Mumbai, 1997.
3. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw Hill Inc.,1997.

REFERENCES:

1. Freeman Neural network : Algorithms Applications and Programming Techniques,1991
2. Goldberg, Genetic Algorithm in Search, Optimization, and Machine Learning, Addison Wesley Publishing Company, Inc. 1989.
3. Tsoukalas L.H., and Robert E.Uhrig, Fuzzy and Neural approach in Engineering, John Wiley and Sons, 1997.
4. Millon W.T., Sutton R.S., and Webrose P.J., Neural Networks for control, MIT Press,1992.
5. MATLAB Neural Network Tool Box, mathworks publications, 2011.
6. MATLAB Fuzzy Logic Tool Box Manual mathworks publications, 2011.
7. R. Eberhart, P.simpson and R.Dobbins,Computional Intelligence PC Tools, AP Professional, Boston, 1996.

OUTCOMES:

At the end of the course the students will be able to

- Identify and describe soft computing techniques and their roles in building intelligent machines.
- Recognize the feasibility of applying a soft computing methodology for a particular problem.
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
- Effectively use existing software tools to solve real problems using a soft computing approach.
- Evaluate and compare solutions by various soft computing approaches for a given problem.

EIBY64	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the knowledge on design and manner of operation of power electronic converters.
- To understand the vital role of power electronics in introducing renewable energy, in the power system to enhance energy saving.

MODULE I INTRODUCTION **9**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

MODULE II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION **9**

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

MODULE III POWER CONVERTERS **9**

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing Wind: three phase AC voltage controllers- AC - DC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

MODULE IV ANALYSIS OF WIND AND PV SYSTEMS **9**

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system.

MODULE V HYBRID RENEWABLE ENERGY SYSTEMS **9**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

Total Hours: 45

REFERENCES:

1. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
5. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi, Ist edition, 2006.

OUTCOMES:

The student will be able to

- demonstrate a comprehensive and systematic knowledge of the operation of AC generators and transformers.
- apply the principle features of different power electronic devices and appropriate converter configurations for renewable energy applications.
- demonstrate a comprehensive and systematic understanding of the specific design requirements of stand-alone and grid-connected PV systems.
- critically analyse the operation of variable-speed generators used in wind turbines and determine the appropriate use of different configurations for specific applications.

EIBY65 NANOTECHNOLOGY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES :

- To make the students acquainted with the applications of nanotechnology in various fields such as nanoelectronics, industrial, biomedical and aerospace.

MODULE I NANOTECHNOLOGY **5**

Introduction and definition of nanotechnology, Introduction, Definition, Length scales, Importance of Nanoscale and Technology, History of Nanotechnology, Future of Nanotechnology: Nano Technology Revolution, Silicon based Technology.

MODULE II NANOELECTRONIC APPLICATIONS **8**

Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design – ferroelectric thin film properties and integration – calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array

MODULE III INDUSTRIAL NANOTECHNOLOGY **8**

Solar cells - Thin film Si solar cells - Chemical semiconductor solar cells - Dye sensitized solar cells - Polymer solar cells - Nano quantum dot solar cells - Hybrid nano-polymer solar cells - Fuel Cells – principle of working – basic thermodynamics and electrochemical principle – Fuel cell classification – Fuel cell Electrodes and Carbon nano tubes – application of power and transportation.

MODULE IV BIOMEDICAL APPLICATIONS **8**

Nanoparticles and Micro–organism, Nano-materials in bone substitutes & Dentistry, Drug delivery and its applications, Biochips- analytical devices, Biosensors- Natural nanocomposite systems as spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Polymeric nanofibres – Implications in Neuro science, tissue engineering and cancer therapy. Poly electrolyte multilayers- coated colloids- smart capsules. Colloids and colloids assembly of bio nanotechnology. Micro emulsions in nanotechnology

MODULE V AEROSPACE APPLICATIONS **8**

Nano and pico satellites - Black box using nanosensors, CNT based electronic noses- CNT based lab on a chip/biochip- CNT in epoxy composites - fuel cells for onboard aircraft systems- functionalized carbon nanotubes in ballistic protection- Zyvere Nanocoatings- scratch, chemical and UV resistance.

MODULE VI BIO-MOLECULAR MACHINES **8**

Characterization of molecular mission- Molecular shuttle-Electrochemical Energy- Molecular Machines powered by Light energy- Molecular Switching- Chemical Switching and Electrochemical Switching- Self assembled nano reactors- Molecular nano reactors- Nano covalent system- Macro Molecular Nano reactions miscelles and Polymers- Bio macro nano molecular reactions- Protein cages

Total Hours : 45

REFERENCES:

1. Springer handbook of nanotechnology by Bharat Bhushan
2. MEMS and nanotechnology – Based sensors and devices communication, Medical and Aerospace applications - A.R.Jha.
3. Nanotechnology - A Gentle Introduction to the Next Big Idea, Ratner and Ratner, Prentice Hall PTR, 1st edition, 2002.
4. Handbook of Nanostructured materials (H.S. Nalwa), 5th edition, 2000.
5. Biomedical applications of nanotechnology edited by Vinod Labhasetwar and DiandraL.Lesie – Pelecky, 1st edition, 2007.
6. Nanotechnology: Fundamentals and Applications by Karkare, I.K.International publishing. Pvt limited 2008.
7. David.S.Goodsell, Bio nanotechnology: lessons from nature, wiley – Liss publications, 2004.
8. Nanomaterials, nanotechnologies and design by Michael. F. Ashby, Daniel L.Schodek, Paulo J.Ferriera, elseveir publications, 2009.

OUTCOMES:

The students will be able to

- acquire knowledge of basic, physical properties of organic materials used in nanotechnology.
- obtain an overview of the various applications enabled by Nanotechnology.
- comprehend the basic science behind Nanotechnology.
- become aware of the many career opportunities offered by this emerging field.

EIBY66 INTRODUCTION TO COGNITIVE NEUROSCIENCE

L	T	P	C
3	0	0	3

OBJECTIVES :

- To know about the anatomy of the human brain
- To have a knowledge on organization of sensory system
- To get familiarize with cognitive neuroscience and the methods of measure.

MODULE I ANATOMY OF THE BRAIN **8**

Anatomical co-ordinate system- central and peripheral nervous system- cross anatomical divisions of brain- The cerebrum- Cerebral cortex- ventricular system – connectivity of brain – Neurons.

MODULE II NEUROBIOLOGY OF SENSORY AND MOTOR SYSTEMS **8**

Organization of sensory system in terms of receptors -relay neurons - thalamus and cortical processing of different sensations - principle motor mechanisms of the periphery (muscle spindle) –thalamus- basal ganglia - brain stem - cerebellum and cerebral cortex.

MODULE III ATTENTION, MEMORY AND LEARNING **8**

Selective attention – Involuntary attention – voluntary shifting and dividing of focus of attention- Neuro transmitter basis of attention-Memory and learning – behavioural observations- neural basis of memory- speech and language- neural basis of speech and language- motor theory of speech perception- executive functions.

MODULE IV NEUROPSYCHOLOGICAL PROFILE OF VARIOUS CONDITIONS **8**

Huntington's disease- Parkinson's disease- progressive supranuclear palsy - thalamic degenerative disease - multiple sclerosis - cortical and subcortical dementias - Alzheimer's dementia - AIDS dementia complex etc.,

MODULE V EMOTIONS, COGNITION AND CONCIOUSNESS **8**

Emotions – emotions result from contextual interpretation of autonomic nervous system response-neural basis of emotion-social cognition composed of multiple functions- consciousness as awareness of externally applied stimuli.

MODULE VI METHODS OF COGNITIVE NEUROSCIENCE **5**

Behavioural measures of cognitive and perceptual functions- Invasive neural recordings- non invasive functional neuro imaging methods.

Total Hours : 45

TEXT BOOKS

1. Introduction to cognitive neuroscience- Iiro P. Jaaskelainen(2012) Iiro p. Jaaskelainen & Ventus publishing
2. Clinical Neuroanatomy for Medical Students, Snell, R.S. (1992), Little Brown & Co.: Boston.
3. Textbook of Medical Physiology, Guyton, A.C. Saunders Company: Philadelphia.
4. Behavioral Neurology, Kirshner H.S, (1986). Churchill Livingstone: NY.
5. Principles of neural science, Kandel, E. R, & Schwartz, J. H (1985). Elsevier: NY.

REFERENCES

1. Handbook of Cognitive Neuroscience, Gazaaniga, M.S. (1984). Plenum Press: NY
2. Neuropsychological assessment of neuropsychiatric disorders, 2nd edition, Grant, I. & Adams, K.M. (1996). Oxford University Press: NY.

OUTCOMES:

At the end of the course the student will be able to understand the

- Central and peripheral nervous system
- Neurobiology behind the sensory and motor systems
- Neural basis of memory, speech and language
- Neuropsychological profile of various conditions

SSBY01 SOCIETY, TECHNOLOGY AND SUSTAINABILITY

L	T	P	C
3	0	0	3

OBJECTIVES:

- Aware of new technologies through advances in Science and Engineering.
- To make them realise the profound impact on society.
- Understand the ethical issues raised by technological changes and its effect on society.
- To introduce students a broad range of perspectives on the adoption and use of technologies.
- To make them realize the need of sustainability in the context of emerging technologies.

MODULE I TECHNOLOGY AND ITS IMPACTS **9**

Origin and evolution of technologies – Nature of technology- Innovation – Historical Perspective of technology – Sources of technological change - Co-evolution of technology and economy – Scientific knowledge and technological advance – Science and Engineering aspects of Technology – Impact on the Society – Social and Ethical Issues associated with technological change – Social and environmental consequences - Impact of technological change on human life –Technology and responsibility – Technology and social justice.

MODULE II TECHNOLOGY AND ITS ADVANCEMENT **9**

Sociological aspects of technology – Ethics and technology – Technology and responsibility – International Economics, Globalisation and Human Rights – Sustainability and Technology – Population and environment - Technology, Energy and Environment – Organisations and technological change

MODULE III SOCIETY AND TECHNOLOGY **9**

Impact of technologies on contemporary society – Role of society in fostering the development of technology – Response to the adaption and use of technology – Impact of technology on developer and consumers – Technological change and globalisation.

MODULE IV IMPACT OF A SPECIFIC TECHNOLOGY ON HUMAN WELFARE **9**

Impact of the following technologies on Human life – Medical and Biomedical – Genetics Technology – Electronics and Communications – Electronic media Technology – Information Systems Technology – Nanotechnology – Space Technology and Energy Technology.

MODULE V THE IMPORTANCE OF SUSTAINABILITY **9**

Sustainability – A brief history – Concepts and contexts for sustainability – Ecological imbalance and biodiversity loss – Climate change – Population explosion. Industrial ecology – systems approach to sustainability – Green engineering and technology- sustainable design- sustainable manufacturing- Green consumer movements – Environmental ethics – Sustainability of the planet Earth – Future planning for sustainability.

Total Hours : 45

REFERENCES:

1. Volti Rudi, “Society and Technology Change”, 6th Edition, Worth publishers Inc, USA, 2009.
2. Arthur W.A, “The nature of Technology: What it is and how it evolves”, Free Press, NY, USA, 2009.
3. Winston M and Edelbach R, “Society, Ethics and Technology”, 3rd Edition, San Francisco, USA, 2005.
4. Martin A.A Abraham, ‘Sustainability Science and Engineering: Defining Principles’, Elsevier Inc, USA, 2006.
5. R.V.G.Menon, “Technology and Society”, Pearson Education, India, 2011.

OUTCOMES:

At the end of this course, the students will be able to

- understand the benefits of modern technology for the well-being of human life.
- connect sustainability concepts and technology to the real world challenges.
- find pathway for sustainable society.