UNIVERSITY OF DELHI

NETAJI SUBHAS INSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM

SCHEME OF COURSES FOR M.TECH. (PROCESS CONTROL)

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

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PREAMBLE

I. INTRODUCTION

Higher education is very important for the growth and development of any country. It is a living organ and requires continuous changes to ensure the quality of education. National Knowledge Commission and University Grants Commission have recommended many academic reforms to address the challenges of today's networked globalized world. People are coming together with the help of new technologies which is resulting towards new aspirations, expectations, collaborations and associations. The concept of "work in isolation" may not be relevant and significant anymore. The UGC guidelines on adoption of Choice Based Credit System may be an important step to revamp the processes, systems and methodologies of Higher Educational Institutions (HEIs). The teacher centric mode be changed to learner centric mode. Class room teaching and learning be made effective; relevant and interesting. Concepts and theories be explained with examples, experimentation and related applications.

A culture of discussions, arguments, interpretations, counter-interpretations, re-interpretations, and opposing interpretations must be established. Research should not only be confined to redefinition, extension and incremental change. Innovation & creativity should become an epicenter for all research initiatives. The most important capital is the human capital and thus the ultimate objective is to develop good human beings with utmost integrity & professionalism for this new world.

The Choice Based Credit System supports the grading system which is considered to be better than conventional marks system. It is followed in many reputed institutions in India and abroad. The uniform grading system facilitates student mobility across the institutions within and across the countries and also enable potential employers to assess the performance of the students. The Choice Based Credit System makes the curriculum interdisciplinary and bridge the gap between professional and liberal education.

II. CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions have been moving from the conventional annual system to semester system. Currently many of the institutions have already introduced the choice based credit system. The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required

credits, and adopt an interdisciplinary approach to learning. It is desirable that the HEIs move to CBCS and implement the grading system.

A. Types of Courses

Courses are the subjects that comprise the M.Tech programme.

1. A course may be designed to comprise lectures, tutorials, laboratory work, field work, outreach activities, project work, vocational training, viva, seminars, term papers, assignments, presentations, self-studyetc.ora combination of some of these components.

2. The learning objectives and learning outcomes of each course will be defined before the start of a semester.

3. Courses are of two kinds: Core and Elective.

   i. **Core Course (CC)**: This is a course which is to be compulsorily studied by a student as a core requirement to complete the requirement of B.E. Computer Engineering.

   ii. **Elective Course**: An elective course is a course which can be chosen from a pool of subjects. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency/skill. An elective may be of following types:

      a) **Discipline Centric Elective (ED)**: It is an elective course that adds proficiency to the students in the discipline.

      b) **Open Elective (EO):** It is an elective course taken from other engineering disciplines that broadens the perspective of an Engineering student.

4. Each course contributes certain credits to the programme. A course can be offered either as a full course (4 credits) or as a half course (2 credits). A full course is conducted with 3 hours of lectures and either 1 hour of tutorial or 2 hours of practical work per week. A half course is conducted with 2 hours of lectures.

5. A student of Postgraduate programme has to accumulate about 40% credits from the Core Courses and the remaining credits from the Elective Courses to become eligible for the award of degree/ diploma/ certificate programmes.

6. A course (full/half) may also be designed without lectures or tutorials. However, such courses may comprise Field work, Outreach activities, Project work, Vocational Training, Seminars, Self-study etc. or a combination of some of these.

7. A Project work/ Dissertation is considered as a special course involving application of the knowledge gained during the course of study in exploring, analyzing and solving complex problems in real life applications. A candidate completes such a course on his own with an advisory support by a teacher/faculty member.

B. Examination and Assessment

The following system will be implemented in awarding grades and CGPA under the CBCS system.

1. **Letter Grades and Grade Points:** A 10-pointgradingsystem shall be used with the letter grades as given in Table 1 below:

Table1: Grades and Grade Points

Letter Grade	Grade point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (absent)	0

2. **Fail grade:** A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. If the student does not want to reappear in an elective subject (that is ED, EO *but not CC courses*) then he/she can re-register afresh for a new elective subject.

3. **Non-credit course:** For noncredit courses, 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA. However, a student must get satisfactory to get the degree.

4. **Fairness in Assessment:** The CBCS promotes continuous evaluation system where end semester examinations weightage should not be more than 60%. The Departments should design their own methods for continuous evaluation. They have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi & teaching, learning methods. In this regard, the checks and balances be implemented which would enable Departments effectively and fairly carry out the process of assessment and examination.

5. **Computation of SGPA and CGPA:** The following procedure shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits and the grade points scored in all the courses of a semester, to the sum of the number of credits of all the courses taken by a student, that is:

$$SGPA(S_i) = \frac{\sum C_j \times G_j}{\sum C_j}$$

Where S_i is the i^{th} semester, C_j is the number of credits of the j^{th} course of that semester and G_j is the grade point scored by the student in the j^{th} course.

ii. The CGPA is also calculated in the same manner taking into account all the courses taken by a student over all the semesters of a programme, that is:

$$CGPA = \frac{\sum C_i \times SGPA(S_i)}{\sum C_i}$$

where $SPGA(S_i)$ is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

iv. CGPA shall be converted into percentage of marks if required, by multiplying CGPA with 10.

III. PROGRAMME STRUCTURE

1. The M.Tech. Process Control programme PC consists of 4 semesters, normally completed in 2 years for Full-Time and 6 semesters, normally completed in 3 years for Part-Time. The total span period cannot exceed 4 years for Full-Time and 5 years for Part-Time.

2. The courses offered in each semester are given in the **Semester-wise Course Allocation.**

3. The discipline centric subjects under CC and ED categories are listed for each discipline separately.

4. A course may have pre-requisite courses that are given in the **Semester-wise Course Allocation**. A student can opt for an elective only if he/she has fulfilled its pre-requisites.

5. A student has to register for all electives before the start of a semester.

IV. COURSE CODIFICATION

The codes for various Postgraduate Program are as follows:

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i. Department of Electronics and Communication Engineering: EC
   1. Signal Processing-ECSP
   2. Embedded System and VLSI-ECES

ii. Department of Computer Engineering:
   1. Information System-COIS

iii. Department of Instrumentation and Control Engineering: IC
   1. Process Control-ICPC
   2. Industrial Electronics-ICIE
   3. Mechatronics-ICMT
   4. Biomedical Instrumentation-ICBI

iv. Department of Biotechnology: BT
   1. Biochemical Engineering -BTBC
   2. Bioinformatics-BTBF

v. Manufacturing processes and Automation Engineering: MPAE
   1. CAD CAM-MACD
   2. Manufacturing process and Automation Engineering.-MAMP
   3. Production Engineering-MAPE
   4. Engineering Management- MAEM
   5. Nanotechnology- MANT

The codes for Departmental core subjects and Domain-specific Electives are specific to each Discipline. The first two characters are derived from Departmental codes listed above.

For **Ist semester**, the codes are:

PCC01	CC
PCC02	CC
PCD**	Elective
PCD**	Elective
PCD**	Elective
EO***	Open Elective

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For **II[nd] semester**, the codes are:

PCC03	CC
PCC04	CC
PCD**	Elective
PCD**	Elective
PCD**	Elective
EO***	Open Elective

For **III[rd] semester**, the codes are:

PCD**	Elective
PCD**	Elective
PCD**	Elective
PCC05	Seminar
PCC06	Major Project

For **IV[th] semester**, the codes are:

PCC07	Dissertation

- Code as specified in table 3 for discipline centric elective

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V. EVALUATION SCHEME

The courses are evaluated on the basis of continuous assessments, mid-semester exams and end-semester exams. The weightage of each of these modes of evaluation for the different types of courses are as follows.

Type of Course	CA	Mid Semester Exam (Theory)	End-semester Exam (Theory)	Continuous Assessment (Lab)	End-semester Exam (Lab)
CC/ED/EO Theory with Tutorial	25	25	50	Nil	Nil
CC/ED/EO Theory with Practical	15	15	40	15	15
Major Project and Dissertation	Nil	Nil	Nil	40	60

VI. DECLARATION OF RESULTS

The M.Tech.(PC) programme consists of 82 credits. CGPA will be calculated on the basis of the best 78 credits earned by the student.

VII. EVALUATION AND REVIEW COMMITTEE

The Committee of Courses and Studies in each department shall appoint one or more Evaluation-cum-Review Committees (ERC), each committee dealing with one course or a group of courses. This ERC consists of all faculty members who are likely to teach such courses in the group. Normally Head of the Department shall be ERC Chairman.

The ERC has the following functions-

(i) To recommend appointment of paper setters/examiners of various examinations at the start of each semester.

(ii) To prepare quizzes, assignments, test papers etc. for Continuous Assessment (CA), Mid-Semester examination (MS) and End Semester (ES) examination and to evaluate them. Normally, each concerned faculty member, who is also a member of ERC, will do this job for his/her class. However, in exceptional circumstances any part of the work may be entrusted to some other member of the ERC.

(iii) To consider the individual representation of students about evaluation and take remedial action if needed. After scrutinizing, ERC may alter the grades awarded upward/downward. The decision of the ERC shall be final.

(iv) To moderate assignments, quizzes etc. for courses given by each of the concerned faculty members for his/her class with a view to maintain uniformity of standards.

(v) To review and moderate the MS and ES results of each course with a view to maintain uniformity of standards.

(vi) To lay guidelines for teaching a course.

VIII. ATTENDANCE, PROMOTION AND DETENTION RULES

1. A student should normally attend all the classes. However, a student will be allowed to appear in the examination if he/ she has put in a minimum of 75% attendance separately in each course for which he / she has registered. A relaxation up to a maximum of 25% may be given on the production of satisfactory evidence that (a) the student was busy in authorized activities, (b) the student was ill.
2. A student should submit the evidence to the fact 1(a) and / or 1(b) above within seven working days of resuming the studies. Certificates submitted later will not be considered.
3. No relaxation in attendance beyond 25% is permitted in any case.
4. A student may re-register for a course if he/ she want to avoid a decrement in the grades.
5. There shall be no supplementary examinations. A student who has failed in a course will have to re-register for the course in a subsequent year.
6. If the student does not want to reappear in an elective course (that is, ED, EO, but not CC courses) then he/she can re-register afresh for a new elective course.

IX. DECLARATION OF RESULTS

1. The M.Tech (PC) programme consists of 82 credits. A student will be awarded the degree if he/she has earned all 82 credits.
2. CGPA will be calculated on the basis of the best 78 credits earned by the student.
3. The candidate seeking re-evaluation of a course shall apply for the same on a prescribed proforma along with the evaluation fee prescribed by the university from time to time only for the End Semester Examination within seven days from the date of declaration of result.
4. The Institution/University may cancel the registration of all the courses in a given semester if
   i. The student has not cleared the dues to the institution/hostel.
   ii. A punishment is awarded leading to cancellation of the student's registration.

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X. CURRICULUM MODIFICATION

The curriculum will be updated regularly within a period of 5 to 10 years since last revision, to keep pace with the advancements in the field of Process Control.

XI. CENTRAL ADVISORY COMMITTEE

There shall be a Central Advisory Committee consisting of the following—

a) Dean, Faculty of Technology, Chairman
b) Dean PGS
c) Head of Institution
d) Heads of Departments running M.Tech Courses

XII. PROGRAMME EDUCATIONAL OBJECTIVES

1- Practice the knowledge of Process Control Engineering and allied and related fields.

2- Demonstrate technical, communication skills and team sprit along with leadership qualities to pursue career in broad areas of Process Control Engineering.

3- Engage in life-long learning through independent study and research.

4- Undertake responsibilities for societal, environmental and ethical causes.

XIII- PROGRAMME OUTCOMES

1. Acquire knowledge of Process Control Engineering with ability to evaluate, analyze and synthesize knowledge related to Process control

2. Analyze complex problems related to Process Control Engineering and synthesize the information for conducting research.

3. Think laterally to solve problems related to Process Control Engineering and provide/suggest a range of solutions considering health, safety, societal, and environmental factors.

4. Extract knowledge through literature survey, experimentation and appropriate research methodology, techniques and tools.

5. Understand group dynamics and rational analysis in order to achieve common goals.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

SCHEME-SEMESTER-WISE COURSE ALLOCATION FULL-TIME

M.TECH. PROCESS CONTROL (FT) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCC01	CC	Modern Control Theory	3	0	2	4	15	15	40	15	15	100
PCC02	CC	Introduction to Process Control	3	0	2	4	15	15	40	15	15	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO***	EO	Open Elective #	-		--	4	-	-	-	-	-	100
		TOTAL	18	3	6	24						
				$								

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students.

M.TECH. PROCESS CONTROL (FT) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCC03	CC	Advanced Process Control	3	0	2	4	15	15	40	15	15	100
PCC04	CC	Discrete time Control System	3	0	2	4	15	15	40	15	15	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO**	EO	Open Elective #	-		--	4	-	-	-	-	-	100
	TYPE	TOTAL	18	3	6	24						
				$								

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students.

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M.TECH. PROCESS CONTROL (FT) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCC05	CC	Seminar	0	0	4	2	100	-	-	-	-	100
PCC06	CC	Major Project	0	0	-	6	-	-	-	40	60	100
		TOTAL	6	1	-	20						
			$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students.

M.TECH. PROCESS CONTROL (FT) SEMESTER IV

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCC07	CC	Dissertation	0	0	-	14	-	-	-	40	60	100
		TOTAL	0	0	-	14						
			$									

$- the actual weekly load will depend upon the electives chosen by the students.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

SCHEME- SEMESTER-WISE COURSE ALLOCATION PART-TIME

M.TECH. PROCESS CONTROL (PT) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCC01	CC	Modern Control Theory	3	0	2	4	15	15	40	15	15	100
PCC02	CC	Introduction to Process Control	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	9	1	4	12						
			$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students.

M.TECH. PROCESS CONTROL (PT) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCC03	CC	Advanced Process Control	3	0	2	4	15	15	40	15	15	100
PCC04	CC	Discrete time Control System	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	9	1	4	12						
			$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students.

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M.TECH. PROCESS CONTROL (PT) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCD**	ED	Elective #	-	-	-	-	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	-	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	-	-	-	-	-	-	100
		TOTAL	9	2	2	12						
			$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students.

M.TECH. PROCESS CONTROL (PT) SEMESTER IV

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
		TOTAL	9	2	2	12						
			$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

M.TECH. PROCESS CONTROL (PT) SEMESTER V

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
PCC05	CC	Major Project	0	0	-	6				40	60	100
		TOTAL	6	1	2	14						
			$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students

M.TECH. PROCESS CONTROL (PT) SEMESTER VI

CODE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
						Theory			Practical		Total
						CA	MS	ES	Int	Ext	
PCD**	Elective #	-	-	-	4	-	-	-	-	-	100
PCC06	Seminar	0	0	4	2	100	-	-	-	-	100
PCC07	Dissertation	0	0	-	14	-	-	-	40	60	100
	TOTAL	0	0	4	20						
		$									

#- The LTP allocation, Evaluation scheme and pre-requisites for Electives are given in tables 3-4. The course code will depend upon student's choice of elective (s).
$- the actual weekly load will depend upon the electives chosen by the students

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TABLE.3- LIST OF DISIPLINE CENTRIC ELECTIVE

CODE	COUSRE OF STUDY	PREREQUISITE	L	T	P	C
PCD01	Power Electronics	____	**3**	**1/0**	**0/2**	**4**
PCD02	Intelligent Instrumentation	____	**3**	**1/0**	**0/2**	**4**
PCD03	Random Process	____	**3**	**1/0**	**0/2**	**4**
PCD04	Fault diagnostics	____	**3**	**1/0**	**0/2**	**4**
PCD05	Parameter estimation and system identification	____	**3**	**1/0**	**0/2**	**4**
PCD06	Model predictive control	____	**3**	**1/0**	**0/2**	**4**
PCD07	Intelligent control	____	**3**	**1/0**	**0/2**	**4**
PCD08	Optimization techniques	____	**3**	**1/0**	**0/2**	**4**
PCD09	Robotics	Electrical Machines/Sensors	**3**	**1/0**	**0/2**	**4**
PCD10	Distributed Digital Control System	Discrete Time Control system	**3**	**1/0**	**0/2**	**4**
PCD11	Optimal control	----------	**3**	**1/0**	**0/2**	**4**
PCD12	Advanced digital signal processing	Signals and Systems/DSP	**3**	**1/0**	**0/2**	**4**
PCD13	Robust control	Control System	**3**	**1/0**	**0/2**	**4**
PCD14	Electric drives and control	Power Electronics	**3**	**1/0**	**0/2**	**4**
PCD15	Microcontrollers based system design	Microprocessor	**3**	**1/0**	**0/2**	**4**
PCD16	Microprocessor based system design	Microprocessor	**3**	**1/0**	**0/2**	**4**
PCD17	Application of FPGA in process control	Process Control	**3**	**1/0**	**0/2**	**4**

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PCD18	MEMS and NEMS	Transducer and Components	**3**	**1/0**	**0/2**	**4**
PCD19	Multi sensor data fusion	Transducer and sensor	**3**	**1/0**	**0/2**	**4**
PCD20	Industrial data communication	___	**3**	**1/0**	**0/2**	**4**
PCD21	RDBMS	___	**3**	**1/0**	**0/2**	**4**
PCD22	Advances in artificial intelligence	___	**3**	**1/0**	**0/2**	**4**
PCD23	Soft Computing	___	**3**	**1/0**	**0/2**	**4**
PCD24	Process Dynamics and Control	Process Control	**3**	**1/0**	**0/2**	**4**
PCD25	Machine dynamics and control	Electrical Machines	**3**	**1/0**	**0/2**	**4**
PCD26	Selected topics in instrumentation and Control	___	**3**	**1/0**	**0/2**	**4**
PCD27	Advanced PID controller	Control System	**3**	**1/0**	**0/2**	**4**

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TABLE 4 : LIST OF OPEN ELECTIVES							
LTP Allocation			**Evaluation Scheme**				
L	**T**	**P**	**CA**	**MS**	**ES**	**Int**	**Ext**
3	**1**	**0**	**25**	**25**	**50**	**-**	**-**
Code	**Name of Elective**		**Pre-Requisites**				
EO001	Technical Communication		None				
EO002	Disaster Management		None				
EO003	Basics of Finance Management		None				
EO004	Basics of Human Resources Management		None				
EO005	Project Management		None				
EO006	Basics of Corporate Law		None				
EO007	Biological computing		None				
EO008	Basic of social science		None				
EO009	Entrepreneurship		None				
EO010	Social work		None				
EO011	IP and Patenting		None				
EO012	Supply Chain Management-Planning and logistics		None				
EO013	Organization Development		None				
EO014	Industrial Organisation and Managerial Economics		None				
EO015	Global Strategy and Technology		None				
EO016	Engineering System Analysis and Design		None				
EO017	Biology for Engineers		None				
EO018	Energy, Environment and Society		None				
EO019	Public Policy and Governance		None				

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

COURSE CONTENTS OF CORE COURSE AND DISCIPLINE CENTRIC ELECTIVES

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCC01	**Modern Control Theory**	**4**	3-0-2	Nil

Course Objectives:

- Introduce the basic concepts of control system and analysis.
- To understand the design of various compensators and their functions.
- To understand the state variables and its application in modeling.
- Introduction to basic mechanism of stability criterion and controllers.

Course Outcome:

The students will be able to

- Understanding on the various laws of control system.
- Introduction of state variables and its applications.
- The understanding of nonlinear systems and their stability.

State Space representation of systems, solution of state equations, controllability and observability, design of control system via state space, linear state feedback design, asymptotic observer and compensator design, stability analysis using Lyapunov methods, local and global stability for linear and non-linear systems. Direct and Indirect adaptive Control, self-tuning regulator, Model reference adaptive control, Least square estimates and the issues related to parameter adaptation, variable structure control, case studies of various engineering control problems may be used to provide insights and useful design guideline. Non-Linear Control: Types of non-linearities, describing function approach, phase plane method, stability of non-linear systems, jump resonance.

Suggested Readings:

1 M. Gopal, “Digital Control and State Variable Analysis”, Tata McGraw-Hill Education
2. Katsuhiko Ogata, “Modern Control Engineering”, Prentice Hall.
3. K.J Astroms and B.Wittenmark, “Computer Controlled Systems- Theory and Design” Prentice Hall.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCC02	**Introduction to Process Control**	**4**	3-0-2	Nil

Course Objectives:

- Introduce the basic concepts of process control.
- To understand the design of various models their analysis.
- To understand different controllers and their applications.
- Introduction of PLC and its programming.

Course Outcome:

The students will be able to

- Understanding on the various laws of process Control.
- Introduction of different controllers and their applications.
- The understanding of different control schemes used in process control.

Incentives for chemical process Control, Design aspects of process control system, Hardware for process control system. Modeling the Dynamic and static behavior of Chemical Process. Linearization of nonlinear systems. Dynamic behavior of 1st order, 2nd order and Higher- order systems. Introduction to feedback Control, Dynamic Behavior of feedback Controlled processes, stability analysis of feedback systems, Design of Feedback Controllers, Frequency Response Analysis of Linear Processes, Design of feedback Control Systems using Frequency Response Techniques. Introduction to Proportional (P), Integral (I), Derivative (D) controllers, PI & PID controllers. Analysis and Design of Advanced Control Systems: Feedback Control of systems with large dead time or Inverse Response, Cascade Control, Selective Control Systems, Split range Control, Feed forward Control, Ratio Control, Inferential Control Systems. Final Control Element: Signal Conversion (I/P or P/I converters) Actuators, pneumatic control valves, valve petitioners and design of pneumatic control valve. Introduction to Programmable Logic Controller (PLC) and its programming.

Suggested Readings:

1. G. Stephanopoulos, “Chemical Process Control. An Introduction to Theory and Practice”, Prentice Hall India.
2. D. E. Seborg, T. F. Edgar, and D. A. Mellichamp, “ Process Dynamics and Control”, Wiley.
3. D. R. Coughanowr, “Process Systems Analysis and Control”, McGraw-Hill.
4. B. A. Ogunnaike and W. H. Ray, “ Process Dynamics, Modeling and Control”, Oxford University Press.
5. B. G. Liptak, “Process Control and Optimization”, Instrument Engineer’s Hand Book, CRC press..
6. F. G. Shinskey, “Process Control System”, McGraw-Hill.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCC03	**Advanced Process Control**	**4**	3-0-2	Process Control

Course Objectives:

- Introduction of different control schemes and their application in process control.
- To understand the relative gain array in MIMO system.
- To understand and design of multivariable controllers and their applications.
- Introduction of statistical process control.

Course Outcome:

The students will be able to

- Understanding of the various control schemes of process Control.
- Introduction of relative gain array in MIMO and their applications.
- To understand the design of multivariable controllers.

Detailed comparison of PID control algorithms. Derivative action on process output vs. error. Problems with proportional "kick" and reset "wind-up". Model Based control: Controller design by direct synthesis for minimum and nonminimum phase system, Internal Model Control (IMC) concept, IMC designs Procedure. IMC-based PID controller, Feed-forward IMC, Digital model-based control -IMC and Dahlin's method. Concept of multivariable process control: Study of interactions and it's effects, Modeling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behaviour.
Relative Gain Array, effect of Interaction on stability and Multi-loop Control system. Multi-loop control Performance through: Loop Paring, tuning, Enhancement through Decoupling, Single Loop Enhancements, Design of multivariable controllers, Some case studies, Introduction to model predictive control (MPC), Introduction to Statistical Process Control, Process Control System Synthesis- Some Case Studies, Some advanced studies in Process Control.

Suggested Readings:

1. B. A. Ogunnaike and W. H. Ray, "Process Dynamics, Modeling and Control", Oxford University Press..
2. B. Roffel and B. H. L. Betlem, "Advanced Practical Process Control", SpringerVerlag Berlin Heidelberg.
3. B.W. Bequette, " Process Control: Modeling, Design and Simulation", Prentice Hall.
4. G. Stephanopoulos, "Chemical Process Control. An Introduction to Theory and Practice", Prentice Hall India.
5. D. E. Seborg, T. F. Edgar, and D. A. Mellichamp, "Process Dynamics and Control", Wiley.
6. B. Roffel and B. H. L. Betlem, "Process Dynamics and Control", John Wiley & Sons Ltd.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCC04	**Discrete Time Control System**	**4**	3-0-2	Nil

Course Objectives:

- Introduction of discrete time control system and its representation.
- To understand the time response of discrete time systems.
- To understand the frequency response of discrete systems and their analysis.
- Introduction of state space in discrete time domain.
  Introduction of full order and reduced order observer

Course Outcome:

The students will be able to

- Understanding of the discrete time control system.
- Introduction of time response of discrete time systems.
- To understand the state space in discrete time domain.
- Introduction of full order and reduced order observer.

Introduction to Digital Control, Discrete time System Representation, Sampling and Reconstruction, Modeling discrete time systems by pulse transfer function. Revisiting Z-transform, Mapping of S-Plane to Z-Plane, pulse transfer function of closed loop systems.

Time-response of discrete systems, second order systems. Discrete PID Controller and its application. Stability analysis of discrete time systems, Jury stability test, stability analysis using bilinear transformation, Root locus method.

Frequency Response, Nyquist criteria and Sampling Theorem, Bode Plot and determination of frequency response parameters. Compensator design using Bode Plot. Introduction to State Space in discrete time domain, Various Canonical forms, State equation and its solution, Controllability and Observability, Pole-placement by state feedback, Full order and reduced order observer.

Suggested Readings:

1. Katsuhiko Ogata, “Discrete-Time Control Systems”, Pearson.
2. B. C. Kuo, “Digital Control Systems”, Oxford University Press.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD01	**Power Electronics**	4	3-0-2	Nil

Course Objectives:

- Introduction of power electronics in electrical machines and industrial process control.
- To understand the evolution of power electronics.
- To understand the different types of filters and rectifiers.
- Introduction of different types of converters and their applications.
- Introduction of different types of bidirectional power converters.

Course Outcome:

The students will be able to

- Understanding of basic components of power electronics.
- Introduction of different types of filters and rectifiers.
- To understand the different converters and their applications.
- Introduction of bidirectional power converters.

Introduction: Application of Power Electronics to: Motor control with emphasis on Traction and Industrial Process control, Power Supplies - Revolution in Personal Computers UPS, Power Transmission - Facts Technology, HVDC, Chemical Process, Battery charging, Power extraction from non-conventional energy sources, Automotive electronics, High energy physics Evolution of Power Electronics, Days of Mercury arc rectification--forerunner of Power Electronics, Invention of SCR and its impact, Advent of Self commutated switches and their impact. Structure of Power Electronics: How structurally power electronics differs from low power analog electronics, Different types of switches, Power Diodes: from the viewpoint of an application engineer, SCR: Dev ice structure, Static characteristic, dynamic characteristic constraints of Turn on and Turn off time, different relevant ratings. Diode rectifiers Applications: Power Supplies, Front end converter for ac motor drives, battery charger, and chemical process. Single phase Half wave with R load, Single phase Half wave with R-L load, Single phase Full bridge rectifier with dc link capacitive filter, issue of harmonics, Three phase Full bridge rectifier with dc link capacitive filter, issue of harmonics. AC to DC controlled converters Application: DC Motor Drives, Battery chargers, HVDC transmission. Single phase fully controlled AC to DC converter Principle of operation: Issue of line commutation, Continuous mode of conduction: expression for average, output voltage, Modes of operation in the voltage-current plane, discontinuous mode of conduction, analysis with R-L-E load, significance of R-L-E load, operation as an inverter: constraints for line commutation, Dual converter: motivation, Simultaneous and nonsimultaneous control, input displacement factor, distortion factor, harmonics, Effect of source inductance, Requirement of snubber. Three phase fully controlled ac to dc converter Principle of operation, derivation of average output voltage, Derivation of displacement factor. Inverter mode of operation, Constraints of commutation in inverter mode, Effect of source inductance Limitation of Line commutated converters Single phase unity power factor converter, Principle of switched Power conversion, Bidirectional Power converters. DC- DC Power Converters: Limitations of Linear Power supplies, Switched Power supplies (Buck, Buck-Boost, Boost, Cuk, Fly-back and Forward Converters), Transfer function for these converters. Motivation: DC- AC Power Converters, Principle of operation of Inverters, Half bridge, full bridge, three phase- six step operation, voltage control, PWM techniques.

Suggested Readings:

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design”, John Wiley and sons.
2. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, Prentice Hall India.
3. P.C Sen., “Modern Power Electronics”, Wheeler publishing Company.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD02	**Intelligent Instrumentation**	4	3-0-2	Nil

Course Objectives:

- Introduction of conventional and intelligent sensors and their applications.
- To understand the optical sensors and applications.
- To understand Data acquisition fundamentals and hardware interfacing.
- Introduction of MEMS, NEMS and reliability analysis in Instrumentation.
- Introduction of soft-computing techniques in measurements.

Course Outcome:

- Understanding of sensors and applications.
- Introduction of optical sensors.
- To understand the data acquisition software and hardware interfacing.
- Introduction of MEMS, NEMS and reliability analysis.

Introduction, Drawbacks of conventional sensors, features of intelligent systems, self diagnostics and calibration, communication, integrated systems and sensors, multisensing, recent developments. Transducers and components: General principles, static and dynamic features of a measurement systems, capacitive sensors, thermal sensors, strain gage, PZT, non-contact type sensing, ultrasonic sensors, optical sensors for precise measurements, signal conditioning aspects, sensor linearization, performance enhancements and non-linear compensation, error reduction techniques. Virtual instrumentation: LabVIEW programming environment, data flow and G programming techniques, Data acquisition fundamentals, DAQ hardware, sensor interfacing, grounding and shielding. Various instrumentation busses and their applications in measurement: ISA, PCI, PCMICA, GPIB, Serial buses and their application in measurement. Real time and time critical measurements: PXI based measurements, components of real time measurements, limitations of the windows operating system. LV RT, FPGA for real time measurements. Introduction to MEMS, NEMS, E-Nose. Reliability analysis in instrumentation system. Applications of soft-computing techniques in measurement systems. Future trends in measurement systems.

Suggested Readings:

1. M. Bhuyan, " Intelligent Instrumentation, principles and applications", CRC.
2. Mathivanan, "PC Based Instrumentation" , PHI.
3. Nakra and Chaudhary, "Instrumentation, Measurement and Analysis", TMH.
4. Bentley, " Principles of Measurement Systems", Pearson.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD03	**Random Processes**	4	3-0-2	Nil

Course Objectives:

- Introduction of different types of probability.
- To understand different probability functions and their analysis.
- To understand the random processes.
- Introduction of cross correlation and autocorrelations for different processes and their significance.
- Introduction of power spectral density.

Course Outcome:

- Understanding of probability.
- Introduction of different probability functions.
- To understand the random processes.
- Introduction of cross correlation and autocorrelations for different processes and their significance.
- Introduction of power spectral density.

Introduction to Probability, Axiomatic Definition of Probability, Conditional probability, Independence, Total Probability, Baye's Theorem. Random Variables, continuous and discrete random variables, Probability Mass Function, Cumulative Distribution function, Probability density function and their properties. Joint distribution and density functions. Functions of random variable, pdf of the function of random variable. Expectation, variance and moments of Discrete and Continuous Random variables; Moments of Jointly Distributed Random Variables; Conditional expectation, covariance and correlation. Moment Generating Function. Some popular Random Variables such as Bernoulli, Binomial, Geometric, Poisson, Uniform, Gaussian and Rayleigh distributions. Definition of Random Process, Realizations, discrete and continuous time processes, examples, Probabilistic structure of a random process; Time and Ensemble Averages, Auto-correlation and Auto-covariance Functions, Cross-correlation Function, Stationarity: SSS Process and WSS Process, Autocorrelation function of a real WSS Process and its Properties, Ergodicity and its importance. Spectral representation of a real WSS Process, power spectral density and its properties, Cross-Power Spectral density, Autocorrelation function and power spectral density of a WSS random process, Linear time invariant system with a WSS Process, Analysis of white noise. Examples of Random Processes, Random Sequence, Gaussian Process, Markov Process and Markov Chain. Wiener filter, Application of Wiener's theory in the Compensator design for feedback control systems, Kalman filtering and prediction for continuous and discrete time systems, Modeling of Non-linear systems.

Suggested Readings:

1. V. Sundarapandian, " Proability, Statistics, and Queueing Theory", PHI Learning.
2. Willium Feller, "An Introduction to Probability Theory and Its Applications", John Wiley & Sons.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD04	**Fault diagnostics**			Nil

Course Objectives:

- Introduction of fault diagnosis in the plant.
- To understand different sensors and their analysis in fault diagnosis.
- To understand the fault identification.
- Introduction of Expert systems and real time process analysis.
- Introduction of general issues in fault tolerant systems.

Course Outcome:

The students will be able

- To understand the fault diagnosis in the plant.
- To use different sensors and their analysis in fault diagnosis.
- To understand the fault identification techniques.
- To understand the Expert systems and real time process analysis.
- To have exposure of general issues in fault tolerant systems.

Monitoring and fault diagnosis of plant: the need, maintenance strategies, Condition monitoring methods: electrical, mechanical, various sensors for vibration, temperature, wear debris and oil analysis, Seismic Pickups, Infrared Camera, Particle sensor, oil density sensors. Design methods for fault detection and diagnosis for dynamic systems, using input/output information, System descriptors and mathematical models. Noise analysis: fluid borne, structural borne, air borne noise measurement and analysis.
Fault analysis planning: Introduction, Fault tree analysis, Availability, Failure Prediction assessment, Hazard rate curve, Monte-Carlo Simulation, High Integrity protective system Signal processing: spectrum analysis, time series analysis. Fault identification, Use of parameter identification techniques: case study. Expert systems and real time process analysis: microcomputer interfacing, data acquisition, expert system skills, Introduction to knowledge based systems and rule generation: case study. Human Factors in Engineering Systems: case study, General issues in fault tolerant systems.

Suggested Readings:

1. R.A. Collacott, " Mechanical Fault Diagnosis and condition monitoring", Chapman and Hall.
2. I.evi S.T and Agrawala A.K , "Fault Tolerant System Design", McGraw Hill.
3. T R Addis, "Designing Knowledge – Based System", Prentice-Hall.
5. Rudolph Frederick, " Handbook of Reliability, Availability, Maintainability and Safety in Engineering Design", Stapelberg, Springer-Verlag,.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD05	**Parameter estimation and system identification**	4	3-0-2	Nil

Course Objectives:

- Introduction of system Identification, adaptive control and applications.
- To understand different parameter estimation techniques.
- To understand the MEL, MS, MAP Estimators.
- Introduction of recursive Identification of linear dynamic systems.
- Introduction of ARMA, NARMA, state models and filters.

Course Outcome:

The students will be able

- To understand system Identification, adaptive control and applications.
- To understand different parameter estimation techniques.
- To understand the MEL, MS, MAP Estimators.
- To understand recursive Identification of linear dynamic systems.
- To understand ARMA, NARMA, state models and filters.

Introduction and overview of System Identification, Adaptive Control and Applications, Parameter Estimation; Least Square, Generalized and Recursive Least Square Estimation, Estimator Properties including error bounds and Convergence, MES, ML and MAP estimators, Non-Linear Least Squares. Model structures and Predictors, Recursive identification of Linear dynamic System: RLS, ELS, RML, stochastic approximation, Kalman filter and Extended Kalman filter. ARMA, NARMA and State Models, Convergence analysis, Time varying Parameters.
Books:

Suggested Readings:
1. L Ljung: System Identification - Theory for the User, Prentice-Hall, Englewood Cliffs, N J.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD06	**Model predictive control**	4	3-0-2	Nil

Course Objectives:

- Introduction of model predictive control and some MPC algorithms.
- To understand multivariable MPC.
- To understand the Discrete time MPC.
- Introduction of Main Quadratic programming algorithms.

Course Outcome:

The students will be able

- To understand model predictive control and some MPC algorithms.
- To understand multivariable MPC.
- To understand the Discrete time MPC.
- To understand Main Quadratic programming algorithms.

Introduction to Model Predictive Control: MPC Strategy, Historical Perspective, Industrial Technology. Model Predictive Controllers: MPC Elements, Prediction Model, Objective Function, Obtaining the Control Law, Review of Some MPC Algorithms, Basic Formulation of Predictive control, State Space Formulation. Multivariable Model Predictive Control Formulation: Continuous-time MPC, Continuous-time MPC with Constraints, Discrete-time MPC, Discrete-time MPC with Constraints. Constrained Model Predictive Control: Constraints and MPC, Constraints and Optimization, Revision of Main Quadratic Programming Algorithms, Constraints Handling, 1-norms. Fast Methods for Implementing Model Predictive Control: Piecewise Affinity of MPC, MPC and Multiparametric Programming. Some case studies.

Suggested Readings:

1. E. F. Camacho and C. Bordons, " Model Predictive Control", Springer.
2. B.W. Bequette, "Process Control: Modeling, Design and Simulation", Prentice Hall.
3. J.M. Maciejowski, "Predictive Control with constraints", Printice Hall.
4. D. Bio-Cang., " Model Predictive Control", CRC Press.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD07	**Intelligent control**	4	3-0-2	Nil

Course Objectives:

- Introduction of Intelligent systems.
- To understand different types of single layer and multilayer Neural networks.
- To understand fuzzy logic.
- Introduction of Fuzzy controller and its applications in control systems.

Course Outcome:

The students will be able

- To understand Intelligent systems.
- To understand different types of single layer and multilayer Neural networks.
- To understand fuzzy logic.
- To have exposure of Fuzzy controller and its applications in control systems.

Content:

Biological foundations to intelligent Systems I: Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks. Biological foundations to intelligent Systems II: Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuuzification Methods. Fuzzy Neural Networks and some algorithms to learn the parameters of the network like GA. System Identification using Fuzzy and Neural Network. Fuzzy logic based control: fuzzy controller: Preliminaries–fuzzy sets in commercial products – basic construction of fuzzy controller - analysis of static properties of fuzzy controller – simulation studies – case studies – fuzzy control of smart cars. Neural Network Controller design for Direct and Indirect Adaptive Control. Neuro-fuzzy systems: Neural controllers: Neuro-fuzzy systems: A unified approximate reasoning approach – Construction of rule bases by self learning: System structure and learning algorithm – A hybrid neural network based fuzzy controller with self-learning teacher. Fuzzified CMAC and RBF network based self-learning controllers. Applications of above mentioned techniques to Non-Linear Dynamical Systems.

Suggested Readings:

1. J. M. Zurada, “Introduction to Artificial Neural Systems”, West Publishing Company, St. Paul, Minnesota, 1992
2. Timothy J. Ross, “FUZZY LOGIC WITH. ENGINEERING. APPLICATIONS”, John Wiley and Sons.
3. B. Kosco, “Neural Networks and fuzzy systems: A Dynamic Approach to Machine Intelligence”, PHI.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD08	**Optimization Techniques**	**4**	3-0-2	Nil

Course Objectives:

- Introduction of direct and indirect search methods.
- To understand different constraint and unconstraint optimization.
- To understand linear and nonlinear programming.
- Introduction of GA optimization, Simulated Annealing, PSO, Tabu search and other artificial optimization techniques.

Course Outcome:

The students will be able

- To understand direct and indirect search methods.
- To understand different constraint and unconstraint optimization.
- To understand linear and nonlinear programming.
- To have exposure of GA Optimization, Simulated Annealing, PSO, Tabu search and other artificial optimization techniques.

General: Functions of single and multiple variables - optimality criteria, direct and indirect search methods. Linearization: Constraint optimality criteria, transformation methods based on linearization, Linear and nonlinear programming, Quadratic and Geometric Programming: Quadratic and geometric programming problems, calculus of variations. GA Optimization, Simulated Annealing, PSO, Tabu Search Optimization. Artificial Intelligence in Optimization, Ant Colony system.

Suggested Readings:

1. T.F. Edgar and D.M. Himmelblau," Optimization Techniques for Chemical Engineers", McGraw-Hill.
2. K. Deo, "Optimization Techniques", Wiley Eastern.
3. S.S. Rao, “Optimization Techniques”, Wiley Eastern.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD09	**Robotics**	4	3-0-2	Electrical Machines/Sensors

Course Objectives:

- Introduction of Robotics.
- To understand mathematical modeling using D-H parameters.
- To understand Modeling of different actuators and sensors.
- Introduction of kinematics of different manipulators.
- Introduction of a planar two-link flexible manipulator.

Course Outcome:

The students will be able

- To understand Introduction of Robotics.
- To understand mathematical modeling using D-H parameters
- To understand Modeling of different actuators and sensors.
- To understand the kinematics of different manipulators.
- To have exposure of planar two-link flexible manipulator.

Introduction -- brief history, types, classification and usage, Science and Technology of robots, Elements of robots -- joints, links, actuators, and sensors, Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link.

Mathematical Modeling using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Kinematics of serial robots, Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator.

Kinematics of parallel robots, Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop-closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform. Velocity and statics of robot manipulators Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics.

Dynamics of serial and parallel robots Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar mechanism, Recursive dynamics, Commercially available multi-body simulation software (ADAMS) and Computer algebra software Maple. Motion planning and control Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators. Modeling and control of flexible robots Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators, Numerical simulations results, Experiments with a planar two-link flexible manipulator.

Modeling and analysis of wheeled mobile robots Introduction and some well known wheeled mobile robots (WMR),

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two and three-wheeled WMR on flat surfaces, Slip and its modeling, WMR on uneven terrain, Design of slip-free motion on uneven terrain, Kinematics, dynamics and static stability of a three-wheeled WMR's on uneven terrain, Simulations using MATLAB and ADAMS. Advanced topics in robotics, Introduction to chaos, Non-linear dynamics and chaos in robot equations, Simulations of planar 2 DOF manipulators, Analytical criterion for unforced motion. Gough-Stewart platform and its singularities, use of near singularity for fine motion for sensing, design of Gough-Stew art platform based sensors. Overconstrained mechanisms and deployable structures, Algorithm to obtain redundant links and joints, Kinematics and statics of deployable structures with pantographs or scissorlike elements (SLE's).

Suggested Readings:

1. **Ashitava Ghosal,** "Robotics: Fundamental Concepts and Analysis", Oxford University Press.
2. Fu, Gonzalez and Lee,, "Robotics: Control, Sensing, Vision, and Intelligence", MGH .
3. Mittal & Nagrath, "Robotics and Control", TMH.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD10	**Distributed Digital Control System**	**4**	3-0-2	Discrete time Control System

Course Objectives:

- Introduction of PLC and its applications.
- To understand the supervisory control and data acquisition system.
- To understand the digital controller modes.
- Introduction of distributed data acquisition and control.
- Implementation of direct digital control.

Course Outcome:

The students will be able

- To Understanding of PLC.
- To understand supervisory control and data acquisition system (SCADA).
- To understand the digital controller modes.
- To have exposure of direct digital control.

Programmable Logic Controller (PLC) and its applications. Review of computers in process control: Data loggers, Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. alarms, interrupts. Characteristics of digital data, controller software, linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

Implementation of digital PID algorithms. Introduction to Real Time Control System. Advantages of distributed digital control systems, Evolution of distributed control. Multilayer control hierarchy, Distributed data acquisition and control, data acquisition, Event monitoring, Direct Control, Supervisory Layer, Intra-area coordination, Production Scheduling and operational management, Management information, Implementation of direct digital control, Interfacing considerations. Man Machine interface, data highway and industrial communication protocols, open system architecture. Introduction to Supervisory Control and Data Acquisition (SCADA) System. Component of SCADA system. Some case studies.

Suggested Readings:

1. Popovic & Bhatkar, " Distributed Computer Control System for industrial Automation", Marshel Dekker.
2. S. A. Boyer, "SCADA: Supervisory Control and Data Acquisition", ISA.
3. M. Johnson and M. H. Moradi, "PID Control", Springer-verlang.
4. B. G. Liptak, "Process Control and Optimization", Instrument Engineer's Hand Book, CRC press.
5. B. G. Liptak, "Process Software and Digital Networks", Instrument Engineer's Hand Book, CRC press.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD11	**Optimal Control**	4	3-0-2	Nil

Course Objectives:

- Introduction of optimal control problem.
- To understand the dynamic programming with the help of optimal control.
- To understand the variational approach to optimal control problems.
- Introduction of Pontryagin's minimum principle and state inequality constraints.
- Introduction of variation of extremals.

Course Outcome:

The students will be able

- To understand optimal control problem.
- To understand the dynamic programming with the help of optimal control.
- To understand the variational approach to optimal control problems.
- To understand Pontryagin's minimum principle and state inequality constraints.
- To understand variation of extremals.

Problem formulation – Mathematical model – Physical constraints - Performance measure, Optimal control problem, Form of optimal control, Performance measures for optimal control problem, Selection a performance measure. Dynamic Programming – Optimal control law – Principle of optimality, An optimal control system, A recurrence relation of dynamic programming – computational procedure, Characteristics of dynamic programming solution, Hamilton – Jacobi – Bellman equation. Continuous linear regulator problems, Calculus of variations – Fundamental concepts, Functionals, Piecewise – smooth extremals, Constrained extrema.

Variational approach to optimal control problems – Necessary conditions for optimal control – Linear regulator problems, Linear tracking problems, Pontryagin's minimum principle and state inequality constraints. Minimum time problems – Minimum control – effort problems. Singular intervals in optimal control problems. Numerical determination of optimal trajectories –Two point boundary – valve problems, Methods of steepest decent, variation of extremals, Quasilinearization, Gradient projection algorithm.

Suggested Readings:

1. Donald E. Kirk, "Optimal Control Theory: An Introduction", Prentice-Hall networks series.
2. Anderson .B. D. O, Moore .J. B, "Optimal control linear Quadratic methods", Prentice Hall of India.
3. Sage A. P, White .C. C, "Optimum Systems Control", Prentice Hall.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD12	**Advanced Digital Signal Processing**	4	3-0-2	Signals and Systems/DSP

Course Objectives:

- Introduction of fundamental of digital processing.
- To understand the design of different types of digital filters.
- To understand short time Fourier analysis.
- Introduction of adaptive filters and their applications in processes.
- Introduction of optimal filters.

Course Outcome:

The students will be able

- To understand the fundamental of digital processing.
- To understand the design of different types of digital filters.
- To understand short time Fourier analysis.
- To have the exposure of adaptive filters and their applications in processes.
- To have exposure of optimal filters.

Modern spectral analysis: Review of the theory of random processes, Traditional approaches using the periodogram and DFT methods, Non-linear estimation: the maximum entropy method, Applications to signal analysis and linear prediction. Linear Predictive Coding: Autocorrelation and covariance implementations, Design and interpretation of lattice filters, Applications to speech, bio-information processing, and geophysics. Multirate digital signal processing: Sampling Rate Conversion, Polyphase implementation of FIR filters for rate conversion, multistage implementations with applications to speech and music analysis.
Short Time Fourier analysis: Interpretation as linear filter vs. Fourier transform Filter design techniques, Application to speech and music analysis, Generalized time-frequency representations: Wigner distributions and wavelets. Adaptive filtering: General introduction and overview, FIR filters: MMSE, LMS, and RLS algorithms, Lattice filters: filter derivation and design, Convergence of transversal and lattice filters, The RLS and related algorithms, optimal filters, Multi-sensor adaptive array processing and beam forming. Realization of digital filters using modern tools.

Suggested Readings:

1. Farhang, " Adaptive Filters Theory and Applications", John Wiley.
2. Widrow, B. and Stearns, S. D., " Adaptive Signal Processing", Prentice-Hall.
3. Haykin, S, "Adaptive Filter Theory", Prentice-Hall.
4. Hayes, M., "Statistical Digital Signal Processing and Modeling", Wiley.
5. Kay, S. M., "Modern Spectral Estimation: Theory and Application", Prentice-Hall.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD13	**Robust control**	4	3-0-2	Control System

Course Objectives:

- Introduction of robust control and linear quadratic regulators.
- To understand the Kharitonov theorem robustness.
- To understand robustness of discrete time LQR systems.
- Introduction of Gerchgorin Theorem and its applications in Process Control.
- Introduction of LQG filters.

Course Outcome:

The students will be able

- To understand robust control and linear quadratic regulators.
- To understand the Kharitonov theorem robustness.
- To understand robustness of discrete time LQR systems.
- To have the exposure of Gerchgorin Theorem and its applications in Process Control.
- To have the knowledge of LQG filters.

Introduction to optimal robust control, Linear Quadratic Regulators: return ratio & difference, sensitivity function. Kalman's optimality condition, Gain/phase margins, robustness to time delay and nonlinearity. Characterization of sensitivity, Kharitonov theorem robustness. Singular values - properties, application in stability, robustness and sensitivity, Robustness of discrete time LQR systems, Forward and feedforward controllers, H2, and controller, LQG controller, Industrial applications of H2/LQG control, Gerchgorin Theorem and its applications in Process Control.

Suggested Readings:

1. Michael J. Griemble, "Robust industrial control-Optimal design approach for polynomial systems", Prentice Hall International.
2. S.P. Bhattacharya, Anirudha Datta, and L.H.Kiel, "Linaer Control theory, structure, Robustness and optimization", CRC Press.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD14	**Electric Drives and Control**	4	3-0-2	Power Electronics

Course Objectives:

- Introduction of Electrical Drives and Control.
- To understand the Induction Motor drives.
- To understand synchronous motor drive.
- Introduction of Close loop control of drives.
- Introduction of Motor drives with VSI, CSI and Cycloconverters.

Course Outcome:

The students will be able

- To understand Electrical Drives and Control.
- To understand the Induction Motor drives.
- To understand synchronous motor drive.
- To have the exposure of Close loop control of drives.
- To have the exposure of Motor drives with VSI, CSI and Cycloconverters

Introduction: Electrical Drives, drive characteristics. D.C. motor drives: Rectifier fed drives, Chopper controlled drives. Induction motor drives: Equivalent circuits, speed control, slip energy recovery. Synchronous motor drives: Operation with fixed frequency and variable frequency source. Closed-loop control of drives: D.C. motor drives - Armature Voltage control, Field weakening. A.C. motors - motor drives with VSI, CSI and Cycloconverter.

Suggested Readings:

1. G. K. Dubey, " Fundamentals of Electrical Drives", Alpha Science International.
2. S.B. Dewan, Gordon R. Slemon and A. Straughen, "Power Semiconductor Drives", John Wiley Pub.
3. R. Krishnan, " Electric Motor drives - Modelling, Analysis and Control", PHI India.
4. Bimal K.Bose, "Modern Power Electronics and AC Drives", Pearson Education .

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD15	**Microcontrollers Based System Design**	4	3-0-2	Microprocessor

Course Objectives:

- Introduction of Microcontrollers.
- To understand the PIC microcontrollers.
- To understand 8051 microcontroller and its architecture.
- Introduction of real time applications of microcontrollers.
- To understand interfacing with LCD, ADC, DAC.
- To understand applications and Products of Embedded Systems

Course Outcome:

The students will be able

- To understand the Microcontrollers.
- To understand the PIC microcontrollers.
- To understand 8051 microcontroller and its architecture.
- To have the exposure of real time applications of microcontrollers.
- To understand interfacing with LCD, ADC, DAC.
- To understand applications and Products of Embedded Systems

Introduction to microcontrollers: Processor Architectures: Harvard V/S Princeton, and CISC V/S RISC, Different types of microcontrollers and Embedded systems, Introduction to Memory Technologies, clocking, interrupts, timers, and peripherals. Introduction to PIC microcontrollers, Architecture and pipelining, Concept of program memory and Data Memory, Addressing modes, CPU registers, Instruction set, and simple operations. Introduction to 8051 Microcontroller its Architecture, Pin Diagram, I/O Ports, Internal RAM and Registers, Interrupts, Addressing Modes, Memory Organization and External Addressing, Instruction Set, Assembly Language Programming, Real Time Applications of Microcontroller, Interfacing with LCD, ADC, DAC, Stepper Motor, Key Board and Sensors. Embedded Systems-Introduction, Classification, Processors, Hardware Units, Software Embedded into System, Applications and Products of Embedded Systems, Structural Units in Processor, Memory Devices, I/O Devices, Buses, Interfacing of Processor Memory and I/O Devices, Case Study of an Embedded System for a Smart Card.

Suggested Readings:

1. B. B. Brey, " The Intel Microprocessors, Architecture, Programming and Interfacing", Pearson Education.
2. John B. Peatman, " Design with PIC Microcontrollers", Pearson.
3. Raj Kamal, "Embedded Systems- Architecture, Programming and Design," TMH.
4. V. Udayashankara and M. S. Mallikarjunaswamy, " 8051 Microcontroller", TMH.
5. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearson Education.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD16	**Microprocessor Based System Design**	4	3-0-2	Microprocessor

Course Objectives:

- Introduction of X86 family processors.
- To understand Signal descriptions of 8086.
- To understand 8051 microcontroller and its architecture.
- Introduction of Interrupts and Exceptions of X86 processors.
- To understand 80486 Microprocessor Architecture.
- To understand 8255 PPI and its various modes of operations and interfacing to X86.
- To understand 8251 USART architecture and interfacing, RS-232, IEEE-4-88, Prototyping and trouble shooting.

Course Outcome:

The students will be able

- To understand X86 family processors.
- To understand Signal descriptions of 8086.
- To understand 8051 microcontroller and its architecture.
- To have exposure of Interrupts and Exceptions of X86 processors.
- To understand 80486 Microprocessor Architecture.
- To understand 8255 PPI and its various modes of operations and interfacing to X86.
- To understand 8251 USART architecture and interfacing, RS-232, IEEE-4-88, Prototyping and trouble shooting.

Introduction to Intel X86 Family of Processors, Internal Architecture of 8086 Microprocessor, Programming Model, Organization and Interfacing of Memory. Concept of Physical and Logical memory. Instruction set, Addressing modes, Signal descriptions of 8086 w.r.t Minimum and Maximum mode operations. Timing diagrams. Interrupts and Exceptions of X86 processors. Assembler directives, macros, simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations etc.

Introduction to 80486 Microprocessor Architecture, Concept of Real Mode, Protected Mode, and Virtual 8086 Mode of Operations. Memory Management Registers for implementation of Virtual Address space, Concept of segmentation, Descriptors, and paging. Multitasking and I/O Protection, Interrupt Vector Table in protected Mode. Switching from one mode to other. I/O Interface, Communication Interface with X86 processor, 8255 PPI and its various modes of operations and interfacing to X86. Interfacing keyboard, display, stepper motor interfacing, D/A and A/D converter.

Writing Interrupt service routine. Interfacing of Interrupt Controller and DMA device. Introduction of Personal Computer Architecture, Introduction to DOS and BIOS interrupts, Bus Architectures such as ISA, PCI, GPIB, SCSI, ATA etc. Serial communication standards, Serial data transfer schemes. 8251 USART architecture and interfacing. RS-232. IEEE-4-88, Prototyping and trouble shooting.

Suggested Readings:

1. D. V. Hall, “Microprocessors and Interfacing”, TMGH.
2. Hans-Peter Messmer, “Indispensable PC Hardware Book”, Addison-Wesley.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD17	**Application of FPGA in Process Control**	4	3-0-2	Process Control

Course Objectives:

- To understand the Programmable Logic: ROM, PLA, PAL, PLD, PGA-Featurs.
- To understand the Altera series-Max 5000/7000 series and Altera FLEX Logic-10000 series.
- To understand the FPGA: Field Programming Gate Arrays-Logic blocks,.
- Introduction of Xilinx XC4000 and ALTERA's 8000/10000 FPGAs.
- To understand Digital Front end, digital design tools for FPGAs and ASICS.
- To understand the applications of FPGA in Process Control.

Course Outcome:

The students will be able

- To understand the Programmable Logic: ROM, PLA, PAL, PLD, PGA-Featurs.
- To understand the Altera series-Max 5000/7000 series and Altera FLEX Logic-10000 series.
- To understand the FPGA: Field Programming Gate Arrays-Logic blocks,.
- Introduction of Xilinx XC4000 and ALTERA's 8000/10000 FPGAs.
- To have the exposure of Digital Front end, digital design tools for FPGAs and ASICS.
- To understand the applications of FPGA in Process Control.

Programmable Logic: ROM, PLA, PAL, PLD, PGA-Featurs, Programming and applications using complex using logic devices, Altera series-Max 5000/7000 series and Altera FLEX Logic-10000 series CPLD, AMDs CPLD (Mach 1 to 5), Cypres FLASH 370, Device technology, Lattice PLST's architectures-3000 series-speed performance and system programmability. FPGA: Field Programming Gate Arrays-Logic blocks, routing architectures, design flow technology mapping for FPGA, Case Studies, Xilinx XC4000 and ALTERA's 8000/10000 FPGAs: AT&T ORCA's (Optimized Reconfigurable Cell Array): ACTEL's ACT-1,2,3 and their speed performance. Digital Front end, digital design tools for FPGAs and ASICS: using mentor graphics EDA tool, (FPGA Advantage)-Design flow using FPGAs. Case studies: Applications in Process Control.

Suggested Readings:

1. S. Trimberger, "Field Programming Gate Arrays" Kluwer Academic publications.
2. John V. Oldfield, Richard C. Dore, "Field Programming Gate Arrays", Wiley Publications.
3. P.K Chan and S. Mourad, "Digital Design using Field Programming Gate Arrays" Tata McGraw-Hill Publishing Company Limited.
4. Parag K. Lala, "Digital System Design using Programmable Logic Devices", BSP.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD18	**MEMS and NEMS**	4	3-0-2	Transducer and components

Course Objectives:

- To understand the Introduction and origin of MEMS.
- To understand the Classification and terminology of MEMS sensors.
- To understand the Modelling and numerical analysis of some micro sensors.
- Introduction of MEMS material and MEMS switch.
- To understand Surface micro machining.
- To understand the MEMS based microwave circuits and NEMS devices using CAD tools.

Course Outcome:

The students will be able

- To understand the Introduction and origin of MEMS.
- To understand the Classification and terminology of MEMS sensors.
- To understand the Modelling and numerical analysis of some micro sensors.
- Introduction of MEMS material and MEMS switch.
- To have the exposure of Surface micro machining.
- To have the exposure of MEMS based microwave circuits and NEMS devices using CAD tools.

Introduction and origin of MEMS, driving force for MEMS development, emergence, devices and application, scaling issues. Classification and terminology of MEMS sensors, evolution of semiconductor sensors, sensor characterization basic concept of acoustic, mechanical, magnetic, radiation, thermal sensors and integrated sensors, Modelling and numerical analysis of some micro sensors. Actuation in MEMS devices, electrostatic actuation, parallel plate capacitor-cantilever beam based movement, comb-drive structures, Modelling and numerical analysis of some micro actuators.

The MEMS switch; Cantilever based MEM switch, Membrane based switch design microwave material and mechanical considerations. MEMS Material, thin film deposition, lithography and etching. Bulk micro machining: Introduction, etch-stop techniques, dry etching, buried oxide process, silicon fusion bonding, and anodic bonding. Surface micro machining: Introduction, sacrificial layer technology, material systems in sacrificial layer technology, plasma etching, combined IC technology and anisotropic wet etching. Microstereo-lithography: Introduction, Scanning Method, Projection Method, Applications. LIGA Process: Introduction, Basic Process and Applications MEMS devices and electronic interfaces. MEMS based microwave circuits: phase shifter, resonators, filters, oscillators. Design, simulation and layout of MEMS and NEMS devices using CAD tools.

Suggested Readings:

1. S.M.Sze, “Semiconductor Sensors”, John Wiley & Sons.
2. M.Elwenspoek, R.Wiegerink, “Mechanical Microsensors”, Springer-Verlag Berlin Heidelberg.
3. Julian W. Gardner, Vijay K. Varadan, “Microsensors, MEMS, and Smart Devices”, John Wiley & Sons Ltd.
4. Massood Tabib-Azar, “Microactuators - Electrical, Magnetic, Thermal, Optical, Mechanical, Chemical and Smart structures”, Kluwer Academic Publishers, New York.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD19	**Multi sensor data fusion**	4	3-0-2	Transducer and Sensor

Course Objectives:

- Introduction of Multisensor data fusion.
- To understand the Elementary applications and techniques for data fusion.
- To understand the Data fusion models.
- Introduction of Data information filter.
- To understand Distributed dynamic sensor fusion.
- To implement the data fusion system.

Course Outcome:

The students will be able

- To understand Multisensor data fusion.
- To understand the Elementary applications and techniques for data fusion.
- To understand the Data fusion models.
- Introduction of Data information filter.
- To have the exposure of Distributed dynamic sensor fusion.
- To have the exposure of implementation of data fusion system.

Multisensor data fusion: Introduction, sensors and sensor data, Use of multiple sensors, Fusion applications. Elementary applications and techniques for data fusion in military and civilian systems, the inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics. Taxonomy of algorithms for multi-sensor data fusion: Multisensor classification; Tracking; Multisensor registration; Data association; Identity declaration. Estimation: Kalman filtering, practical aspects of Kalman filtering, extended Kalman filters. Decision level identifies fusion. Knowledge based approaches.

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion. High performance data structures: Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems within dependability bounds. Implementing data fusion system.

Suggested Readings:

1. David L. Hall, “Mathematical techniques in Multisensor data fusion”, Artech House, Boston.
2. R.R. Brooks and S.S. Iyengar, “Multisensor Fusion: Fundamentals and Applications with Software”, Prentice Hall Inc., New Jersey.
3. Arthur G.O. Mutambara, “Decentralized Estimation and Control for Multisensor Systems”, CRC Press.
4. Arthur Gelb, “Applied Optimal Estimation”, The M.I.T. Press.
5. James V. Candy, “Signal Processing: The Model Based Approach”, McGraw Hill.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD20	**Industrial data communication**	4	3-0-2	Nil

Course Objectives:

- Introduction of Data Communication and Internet.
- To understand application Layers.
- To understand the Web and HTTP – Overview.
- Introduction of DNS–The Internet's Directory Service.
- To understand Transport Layer Introduction.
- To understand Principles of Congestion Control and its applications.
- To understand Introduction to the Link Layer and its Services.

Course Outcome:

The students will be able

- To understand the fundamentals of Data Communication and Internet.
- To understand application Layers.
- To understand the Web and HTTP – Overview.
- Introduction of DNS–The Internet's Directory Service.
- To understand Transport Layer Introduction.
- To have the exposure of Congestion Control and its applications.
- To have the exposure of Link Layer and its Services.

Introduction to Data Communication and the Internet: What Is the Internet? Services Description, Definition of Protocol; The Network Edge – Internet/Network Access Methods; Physical Media; The Network Core – Packet Switching, Circuit Switching; Delay, Loss, and Throughput in Packet-Switched Networks, Overview of Delays; Throughput. Protocol Layers and Their Service Models.

Application Layer: Principles of Network Applications; Network Application Architectures; Application-Layer Protocols; The Web and HTTP – Overview, Non Persistent and Persistent Connections, Message Format. Commands and Replies. Electronic Mail – SMTP, Comparison with HTTP, Mail Message Format, Mail Access Protocols. DNS–The Internet's Directory Service, Services Provided by DNS, How DNS Works, DNS Records and Messages. Socket Programming: Creating Network Applications, with UDP and TCP. Queuing Theory: Birth Death Process, Littel's Formula, Candel's Notation, M/M/1/ queue.

Transport Layer Introduction, Transport-Layer Services, Relationship Between Transport and Network Layers, Multiplexing and Demultiplexing, UDP, Principles of Reliable Data Transfer, Go- Back-N (GBN), Selective Repeat (SR), Connection-Oriented Transport: TCP, its Connection, TCP Segment Structure, RTT, Flow Control, TCP Connection Management, Principles of Congestion Control, Network-Assisted Congestion-Control – ATM ABR Congestion Control, TCP Congestion Control. The Network and Data Link Layers: Concept of Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks, The Internet Protocol (IP): Forwarding and Addressing in the Internet, Datagram Format, IPv4 Addressing, ICMP, Routing Algorithms, The Link-State (LS) Routing Algorithm, The Distance-Vector (DV) Routing Algorithm, Hierarchical Routing, Routing in the Internet, Intra-AS Routing, RIP, OSPF, BGP, Broadcast and Multicast Routing.

Introduction to the Link Layer and its Services, Error-Detection and -Correction Techniques, Checksumming Methods, CRC; Link-Layer Addressing and ARP, Ethernet, Link-Layer Switches, VLANs, MPLS, Industrial Bus Systems, Field Bus, Profi Bus and their Protocol stacks. CAN BUS, I2 BUS.

Suggested Readings:

1. Kurose and Ross, "Computer Networking: A Top-Down Approach".
2. Peterson and Davi, "Computer Networks".
3. Berstecas, " Data Communications".

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD21	**RDBMS**	**4**	3-0-2	Nil

Course Objectives:

- Introduction of Purpose of Database systems.
- To understand Entity relationship model.
- To understand the Relational model.
- Introduction of SQL: Background and Basic Structure.
- To understand Integrity constraints.
- To understand Relational Database Design.
- To understand Object Oriented Databases and case studies.

Course Outcome:

The students will be able

- To understand the Purpose of Database systems.
- To understand Entity relationship model.
- To understand the Relational model.
- Introduction of SQL: Background and Basic Structure.
- To understand Integrity constraints.
- To have the exposure of Relational Database Design.
- To have the exposure of Object Oriented Databases and case studies.

Introduction : Purpose of Database systems – View of data – Data models – Database languages – Transaction management – Storage management – Database Administrator – Database users – Overall System Structure. Entity relationship model: Basic concepts – keys – Entitiy relationship Diagram – Week entities sets – Extended ER features: Specialization – Generalization. Relational model: Structure of relational databases – The relational Algebra – views. SQL: Background – Basic Structure – Set operations – Aggregate functions – null values – Nested sub queries – Derives Relations – views – modification of database – joined relations – data definition languages – Embedded SQL – other SQL features.

Integrity constraints: Domain constraints – Referential Integrity – Assertions – Triggers – Functional Dependencies. Relational Database Design: Pitfalls in Relational Database Design – Decomposition – Normalization using functional dependencies – Normalization using Multilevel Dependencies – Normalization using Join Dependencies. Object Oriented Databases : New Database Applications – The Object Oriented Data Model – Object Oriented Languages – Persistent Programming Languages. Object Relational Databases : Neated relations – Complex types and Object Orientation – Quering with complex Data types – Creation of complex values and objects – Comparison of Object – Oriented Relational databases. Case studies: regarding formation and testing of database for any process industry for Distributed Control System (DCS).

Suggested Readings:

1. C. J. Date, " Introduction to Database Systems", Addison-Wesley.
2. Abraham Silberschatz, Hendry F. Korth, S. Sudharshan, "Database System Concepts", Mc Graw Hill International Edition .

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD22	**Advances in artificial intelligence**	4	3-0-2	Nil

Course Objectives:

- Introduction of Neural Network.
- To understand Information theoretical model.
- To understand the Stochastic Machines and statistical machines.
- Introduction of Neurodynamic programming.
- To understand Hybrid algorithms.
- To understand Genetic algorithm and evolutionary programming.
- To understand learning algorithms and applications in process control.

Course Outcome:

The students will be able

- To understand the Neural Network.
- To understand Information theoretical model.
- To understand the Stochastic Machines and statistical machines.
- Introduction of Neurodynamic programming.
- To understand Hybrid algorithms.
- To have the exposure of Genetic algorithm and evolutionary programming.
- To have the exposure of learning algorithms and applications in process control.

Neural Network: Adaptive Linear Neural Network, Self organizing maps, Self organizing map algorithm, Properties of the Feature Map, Learning Vector quantization, Adaptive pattern classification, Hierarchical vector quantization. Information theoretical model: entropy, Maximum Entropy principle, Mutual information, Kullback-Leibler Divergence, Mutual function as an objective function to be optimized, Maximum mutual information Principle, Infomax and redundancy reduction. Stochastic Machines and statistical machines: Statistical machines, Metropolis algorithm, Simulated Annealing, Gibbs sampling, Boltzmann machine, sigmaoid belief networks, Mean-Field theory, Deterministic Boltzmann machine. Neurodynamic programming: Markovian Decision process, Bellman, optimality criterion, policy iteration, Value iteration, neurodynamic programming, Approximate policy iteration, Q-learning, Hybrid algorithms.

Particle Swarm intelligence, Genetic algorithm and evolutionary programming, Support vector machines, Ant Colony system. Neurodynamics: Dynamical systems, stability of equilibrium states, attractors, neurodynamical methods, Hopefield models, Cohen grossberg theorem. Dynamically driven Recurrent network: Recurrent network architecture, state space model, Computational power of recurrent networks, learning algorithms and applications in process control.

Suggested Readings:

1. Bose and Liang, “Artificial Neural Networks”, Tata Mcgraw Hill.
2. Kosco B, “Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence”, Prentice Hall of India, New Delhi.
3. Simon Haykin, “Neural Networks”, Pearson Education.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD23	**Soft Computing**	4	3-0-2	Nil

Course Objectives:

- Introduction of fuzzy logic.
- To understand the properties of fuzzy sets and fuzzy relations.
- To understand the fuzzy mapping rules and fuzzy implication functions, Applications.
- Introduction of Neural networks.
- To understand Genetic algorithm and evolutionary programming
- To understand Hybrid algorithms.

Course Outcome:

The students will be able

- Introduction of fuzzy logic.
- To understand the properties of fuzzy sets and fuzzy relations.
- To understand the fuzzy mapping rules and fuzzy implication functions, Applications.
- Introduction of Neural networks.
- To have the exposure of Genetic algorithm and evolutionary programming
- To have the exposure of Hybrid algorithms.

Fuzzy Logic: Crisp set and Fuzzy set, Basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, Properties of fuzzy sets, Fuzzy relations. Propositional logic and Predicate logic, fuzzy If – Then rules, fuzzy mapping rules and fuzzy implication functions, Applications.

Neural Networks: Basic concepts of neural networks, Neural network architectures, Learning methods, Architecture of a back propagation network, Applications.

Genetic Algorithms: Basic concepts of genetic algorithms, encoding, genetic modeling.

Hybrid Systems: Integration of neural networks, fuzzy logic and genetic algorithms.

Suggested Readings:

1. S. Rajasekaran and G.A.Vijaylakshmi Pai., "Neural Networks Fuzzy Logic, and Genetic Algorithms", Prentice Hall of India.
2. K.H.Lee.. "First Course on Fuzzy Theory and Applications", Springer-Verlag.
3. J. Yen and R. Langari.. "Fuzzy Logic, Intelligence, Control and Information", Pearson Education.
4. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley Publication, India.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD24	**Process Dynamics and Control**	4	3-0-2	Process Control

Course Objectives:

- To understand the Role of Process Dynamics and Control.
- To understand the Mathematical Models of System.
- To understand the series of Isothermal, Constant-Holdup CSTRs, CSTRs with Variable Holdups.
- Introduction of Distillation process.
- To understand Conventional Control Systems.
- To understand the methods of controller tunings.

Course Outcome:

The students will be able

- To understand the Role of Process Dynamics and Control.
- To understand the Mathematical Models of System.
- To understand the series of Isothermal, Constant-Holdup CSTRs, CSTRs with Variable Holdups.
- Introduction of Distillation process.
- To have the exposure of Conventional Control Systems.
- To have the exposure of controller tunings.

Introduction: Examples of the Role of Process Dynamics and Control, Historical Background Perspective, Motivation for Studying Process Control, General Concepts, Laws and Languages of Process Control, Process Control Laws, Languages of Process Control.

Mathematical Models of System: Fundamentals, Introduction, Uses of Mathematical Models, Scope of Coverage, Principles of Formulation, Fundamental Laws, Continuity Equations, Energy Equation, Equations of Motion, Transport Equations, Equations of State Equilibrium, Chemical Kinetics, Problems, Introduction, Series of Isothermal, Constant-Holdup CSTRs, CSTRs With Variable Holdups, Two Heated Tanks, Gas-Phase, Pressurized CSTR, Nonisothermal CSTR, Single-Component Vaporizer, Multicomponent Flash Drum, Batch Reactor, Reactor With Mass Transfer Ideal Binary Distillation Column, Multicomponent Nonideal Distillation Column, Batch Distillation With Holdup, pH Systems, Equilibrium-Constant Models, Titration-Curve Method, Problems.

Simulation of Models: Gravity-Flow Tank, Three CSTRs in Series, Nonisothermal CSTR, Binary Distillation Column, Multicomponent Distillation Column, Variable Pressure Distillation, Approximate Variable-Pressure Model, Rigorous Variable-Pressure Model, Batch Reactor, Ternary Batch Distillation With Holdup.

Conventional Control Systems: Control Instrumentation, Sensors, Transmitters Control valves, Analog and Digital Controllers, Computing and Logic Devices, Performance of Feedback Controllers, Specifications for Closed loop Response, Load Performance, Controller Tuning, Rules of Thumb, On-Line Trial and Error Ziegler-Nichols Method.

Suggested Readings:

1. W.L. Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, Tata McGraw-Hill Chemical Engineering Series, McGraw-Hill.
2. B. Wayne Bequette, “Process Control: Modeling Design and simulation”, Prentice Hall India.
3. G. Stephanopoulos, “Chemical Process Control: An Introduction to Theory and Practice”, Prentice Hall India.
4. D. E. Seborg, T. F. Edgar, and D. A. Mellichamp, “Process Dynamics and Control”, Wiley.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD25	**Machine Dynamics and Control**	**4**	3-0-2	Electrical Machines

Course Objectives:

- Introduction of Generalized theory and Kron's primitive machine model.
- To understand Sensorless control and flux observers.
- To understand the Multilevel converter-fed induction motor drive.
- Introduction of Vector control of synchronous motor.
- To understand Control of synchronous reluctance motor.
- To understand Brushless dc motor, Switched reluctance motor, Stepper motors and control.

Course Outcome:

The students will be able

- To understand Generalized theory and Kron's primitive machine model.
- To understand Sensorless control and flux observers.
- To understand the Multilevel converter-fed induction motor drive.
- Introduction of Vector control of synchronous motor.
- To have exposure of Control of synchronous reluctance motor.
- To have exposure of Brushless dc motor, Switched reluctance motor, Stepper motors and control.

Generalized theory and Kron's primitive machine model. Modeling of dc machines, Modeling of induction machine, Modeling of synchronous machine, Reference frame theory and per unit system. Control of Induction Motor Drive, Scalar control of induction motor, Principle of vector control and field orientation, Sensorless control and flux observers, Direct torque and flux control of induction motor, Multilevel converter-fed induction motor drive, Utility friendly induction motor drive. Control of Synchronous Motor, Self controlled synchronous motor, Vector control of synchronous motor, Cycloconverter-fed synchronous motor drive, Control of synchronous reluctance motor. Brushless dc motor, Switched reluctance motor, Stepper motors and control.

Suggested Readings:

1. G. K. Dubey, " Fundamentals of Electrical Drives", Alpha Science International.
2. S.B. Dewan, Gordon R. Slemon and A. Straughen, "Power Semiconductor Drives", John Wiley.
3. R. Krishnan, " Electric Motor drives - Modeling, Analysis and Control", PHI.
4. Bimal K.Bose, "Modern Power Electronics and AC Drives", Pearson.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD26	**Selected Topics in Instrumentation and Control**	**4**	3-0-2	Instrumentation and Control

Course Objectives:

- Introduction various advanced topics in instrumentation and Control.

Course Outcome:

The students will be able

To understand various advanced topics in instrumentation and Control and their applications.

Various advanced topics in instrumentation of interest to research and/or of industrial importance.
Various advanced topics in control of interest to research and/or of industrial importance.

Suggested Readings:
The latest related research papers may be acquired from website.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
PCD27	**Advanced PID Controller**	**4**	3-0-2	Control System

Course Objectives:

- Introduction to PID controller.
- To understand Design and implementation of digital PID control algorithms.
- To understand Industrial PID control.
- Introduction of Multivariable PID Control Systems.
- To understand direct synthesis control, Internal Model Control (IMC) and IMC-based PID.
- To understand some advanced studies on PID control.

Course Outcome:

The students will be able

- To understand PID controller.
- To understand Design and implementation of digital PID control algorithms.
- To understand Industrial PID control.
- Introduction of Multivariable PID Control Systems.
- To have the exposure of direct synthesis control, Internal Model Control (IMC) and IMC-based PID.
- To have the exposure of some advanced studies on PID control.

Introduction to Proportional (P), Integral (I), Derivative (D) controllers, PI, PD and PID controllers, Series & parallel PID controller, Weighted PID controller and ISA PID controller. Design and implementation of digital PID control algorithms. PID Controller Implementation Issues: Bandwidth-Limited Derivative Control, Proportional & Derivative kick, Integral windup & anti-windup circuit and ReverseActing Controllers. Industrial PID control, Controller Degrees of Freedom Structure, PID Control Performance: Set-point Tracking, Disturbance Rejection and Noise Suppression, State Space Systems and PID Control, Multivariable PID Control Systems. Tuning of PID controller: online & offline. Model based Control, Direct synthesis control, Internal Model Control (IMC) and IMC-based PID. Automatic PID controller tuning. Tuning of PID controller for Multivariable Control Systems. Introduction to Intelligent PID controllers. Design of PID controller using restrict structure method. Predictive PID control. Some case studies. Some advanced studies on PID control.

Suggested Readings:

1. M. Johnson and M. H. Moradi, “PID Control”, Springer-verlang, London.
2. K. J. Åström, and T. Hägglund, “Advanced PID Controllers”, ISA.
3. K. J. Åström, and T. Hägglund, “PID Controllers: Theory Design and Tuning”, ISA.
4. B. G. Liptak, “Process Control and Optimization”, Instrument Engineer’s Hand Book, CRC press.
5. B. A. Ogunnaike and W. H. Ray, “ Process Dynamics, Modeling and Control”, New York: Oxford University Press.
6. B.Wayne Bequette, “Process Control: Modelling Design and simulation”, Prentice Hall India.
7. D. E. Seborg, T. F. Edgar, and D. A. Mellichamp, “Process Dynamics and Control”, Wiley.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

COURSE CONTENT OF OPEN ELECTIVES

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO001	Technical Communication	3L-1T-0P	4	None

Course Objectives(CO):

1.The course will improve writing and documentation skills of students with emphasis on the importance of effective communication with focus on choice of words, formation of proper sentence structures and writing styles.
2. This will enhance the students capability to prepare technical documents and correspondence.
3. The course will equip the student with good communications skills for placements, preparing SOPs and CVs.
4. The course will sensitize the students towards research ethics, copyright and plagiarism.

Course Content:

- Definition of communication, meaning, importance & process of communication, objectives, types, C's of communication, barriers to communication
- human & non -human communication, distinctive features of human languages
- Business correspondence-definition, meaning and importance of business communication, business letters-purchase, enquiry, quotation, order, followup, acceptance-refusal
- Emphasis on (i) paragraph writing, its kinds, coherence & cohesion
  (ii)writing a paragraph/thesis: selection of topic and its development
  (iii) writing reports, manuals, notices, memos, agendas, minutes
  (iv)Interviews, speeches, presentations,
- Research ethics, methodologies, copyright, plagiarism

Suggested Readings

1. Martin Hewing, " Advanced English Grammar" , Cambridge.
2. Meenakshi Raman & Sangeeta Sharma, "Technical Communication", Oxford University Press.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO002	Disaster Management	3L-1T-0P	4	None

Course objectives(CO):-

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

Unit -I: Introduction

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

Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit -II: Disaster Prone Areas In India

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

Unit -III: Disaster Preparedness And Management

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

Unit -IV: Risk Assessment

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

Unit -V: Disaster Mitigation

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

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India:Perspectives, issues and strategies," New Royal book Company, Lucknow.
2. Sahni, PardeepEt.Al., " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., "Disaster AdminastrationAnd Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO003	**Basics of Financial Management**	**3L-1T-0P**	**4**	**None**

Course Objective(CO):-

- The course's objective is to provide a theoretical framework for considering corporate finance problems and issues and to apply these concepts in practice. In this course, you will enhance your knowledge and understanding of financial management. You will learn how managers should organize their financial transactions effectively and with integrity and how to give everybody the ability and confidence to tackle common financial problems in practice. It will also provide adequate preparation for future finance classes.

Unit I

Nature, scope and objectives of financial management, Time value of money, Risk and return (including Capital Asset Pricing Model).

Unit II

Long term investment decisions: The Capital Budgeting Process, Cash Flow Estimation, Payback Period Method, Accounting Rate of Return, Net Present Value (NPV), Net Terminal Value, Internal Rate of Return (IRR), Profitability Index.

Unit III

Financing Decisions: Sources of long-term financing, Estimation of components of cost of capital, Methods for calculating Cost of Equity, Cost of Retained Earnings, Cost of Debt and Cost of Preference Capital, Weighted Average Cost of Capital (WACC). Capital Structure- Theories of Capital Structure (Net Income, Net Operating Income, MM Hypothesis, Traditional Approach). Operating and Financial leverage. Determinants of capital structure

Unit IV

Dividend Decisions: Theories for Relevance and irrelevance of dividend decision for corporate valuation-Walter's Model, Gordon's Model, MM Approach, Cash and stock dividends. Dividend policies in practice.

Unit V

Working Capital Decisions: Concepts of Working Capital, Operating & Cash Cycles, sources of short term finance, working capital estimation, cash management, receivables management, inventory management.

Suggested Readings:

1. Khan, M.Y. and P.K. Jain, "Financial Management: Text and Problems", Tata McGraw Hill.
2. Srivastava, Rajiv, and Anil Mishra, "Financial Management", Oxford University Press, UK.
3. Chandra, P. , "Financial Management-Theory and Practice", Tata McGraw Hill.
4. Horne, Van; James C., John Wachowicz, "Fundamentals of Financial Management", Pearson Education.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO004	**Basics of Human Resource Management**	**3L-1T-0P**	**4**	**None**

Course Objective(CO):-

- This course is designed to provide students with an understanding of human resource management (HRM) functions within organizations, including an appreciation of the roles of both HRM specialists and line managers in designing and implementing effective HRM policies and practices.

Unit - I

Evolution and growth of human resource management (with special reference to scientific management and Human relations approaches).Role of HR in strategic management.Nature.objectives, scope, and functions of HR management.

Unit - II

Challenges of HR (the changing profile of the workforce - knowledge workers, employment opportunities in BPOs, IT and service industries, Flexi options), Workforce diversity (causes, paradox, resolution of diversity by management).

Unit III

HRD; Human resource management as a profession.Concepts of line-staff in the structure of human resource department and the role of human resource manager.

Unit - IV

Manpower planning -objectives, elements, advantages, process. Job design - (simplification, rotation, enlargement, enrichment and approaches}.Job analysis.Job evaluation.

Unit - V

Recruitment (factors affecting, sources, policy, evaluation). Selection(procedure, tests, interviews). Placement and Induction.

Suggested Readings:

1. Aswathappa K. , " Human Resource and Personnel Management", Tata McGraw-Hill, New Delhi.
2. Chhabra T.N., "Human Resource Management", Dhanpat Rai and Co. Delhi.
3. Saiyadain S. Mirza , " Human Resource Management", Tata Mc-GrawHill, India.
4.Chadha, N.K., "Human Resource Management-issues, case studies, experiential exercises", Sri Sai Printographers, New Delhi.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO005	**Project Management**	**3L-1T-0P**	**4**	**None**

Course Objectives:-

- In this comprehensive course, student will learn the fundamentals of project management: how to initiate, plan, and execute a project that meets objectives and satisfies stakeholders. This course provides a step-by-step guide to planning and executing a project and to develop a manageable project schedule.

Unit-I

Objectives of Project Planning, monitoring and control of investment projects. Relevance of social cost benefit analysis, identification of investment opportunities. Pre-feasibility studies.

Unit-II

Project Preparation: Technical feasibility, estimation of costs, demand analysis and commercial viability, risk analysis, collaboration arrangements; financial planning; Estimation of fund requirements, sources of funds.Loan syndication for the projects.Tax considerations in project preparation and the legal aspects.

Unit-III

Project appraisal: Business criterion of growth, liquidity and profitability, social cost benefit analysis in public and private sectors, investment criterion and choice of techniques. Estimation of shadow prices and social discount rate.

Unit-IV

Project review/control-Evaluation of project. PERT/CPM.resource handling/leveling.

Unit-V

Cost and Time Management issues in Project planning and management , success criteria and success factors, risk management.

Suggested Readings:

1. Ravi Ravindran, " Operations Research and Management Science Handbook", CRC Press.
2. Harold Kerzner, "Applied Project Management: Best Practices on Implementation", John Wiley & Sons.
3. Goodpasture, J. C., "Quantitative Methods in Project Management", J Ross Publishing, Boca Raton, Florida, USA.
4. Meredith, J. R. and Mantel Jr., S. J., "Project Management: A Managerial Approach", John Wiley.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO006	**Basics of Corporate Law**	**3L-1T-0P**	**4**	**None**

Course objectives(CO):

- The objective of this Course is to provide in-depth knowledge of the Corporate laws and process related to integrate these aspects of management studies in decision making within an organization; analyze and interpret management information; make decisions based on the information available; communicate information effectively; understand and apply the theoretical aspects of accounting methods used for collecting, recording and reporting financial information; explain and appraise the taxation laws which govern corporations and individuals.

Unit I: Introduction : Administration of Company Law, characteristics of a company; common seal; lifting of corporate veil; types of companies including private and public company, government company, foreign company, one person company, small company, associate company, dormant company, producer company; association not for profit; illegal association; formation of company, promoters and their legal position, pre incorporation contract and provisional contracts; on-line registration of a company.

Unit II: Documents: Memorandum of association and its alteration, articles of association and its alteration, doctrine of constructive notice and indoor management, prospectus, shelf prospectus and red herring prospectus, misstatement in a prospectus; GDR; book building; issue, allotment and forfeiture of shares, calls on shares; public offer and private placement; issue of sweat capital; employee stock options; issue of bonus shares; transmission of shares, buyback and provisions regarding buyback; share certificate; D-Mat system; membership of a company.

Unit III: Management and Meetings: Classification of directors, additional, alternate and adhoc director; women directors, independent director, small shareholders' director; director identity number (DIN); appointment, who can appoint a director, disqualifications, removal of directors; legal position, powers and duties; key managerial personnel, managing director, manager; meetings of shareholders and board; types of meeting, convening and conduct of meetings, requisites of a valid meeting; postal ballot, meeting through video conferencing, e-voting; committees of board of directors – audit committee, nomination and remuneration committee, stakeholders relationship committee, corporate social responsibility committee; prohibition of insider trading.

Suggested Readings:

1. Hicks, Andrew & Goo S.H., "Cases and Material on Company Law", Oxford University Press
2. Gowar, LCB, "Principles of Modern Company Law", Stevens & Sons, London.
3. Majumdar, A.K., and G.K. Kapoor, "Company Law and Practice", Taxmann, New Delhi
4. Hanningan, Brenda, " Company Law", Oxford University Press, U.K.
5. Sharma, J.P., "An Easy Approach to Corporate Laws", Ane Books Pvt. Ltd., New Delhi
9. Ramaiya, " A Guide to Companies Act", LexisNexis Buttersworthwadhwa.
6. Kannal, S., & V.S. Sowrirajan, "Company Law Procedure", Taxman's Allied Services (P) Ltd., New Delhi.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO007	**BIOLOGICAL COMPUTING**	**3L-1T-0P**	**4**	**None**

Course Objectives(CO):

1. To understand computing in context of biological systems.
2. To understand computing languages needed to solve biological problems.
3. To acquire computational skills for analysis of biological processes through grid computing.
4. To gain knowledge of different biological databases and their usage.
5. To gain innovative insight into DNA computing.

Content:

Introduction, Orientation and UNIX,

Python: Introduction to Variables and Control flow, Python II - Parsing In and Output, Python III - Scripting and Functions, Python IV- Number Crunching and Plotting,

Grid computing, Biogrid, R basics and Visualization, Unix for fast text processing, SQL Database

Biological databases, R for speed, R for fun, Local BLAST, Unit Testing and Code Correctness

DNA computing,

Suggested Readings:

1. H. Bolouri, R. Paton, "Computations in cells & tissues", Springer.
2. Haubold**,** Bernhard**,** Wiehe, "Thomas Introduction to Computational Biology: An Evolutionary Approach", Springer.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO008	**Basics of Social Sciences**	**3L-1T-0P**	**4**	**None**

Course Objectives

- **Social science** is a major category of academic disciplines, concerned with society and the relationships among individuals within a society. It in turn has many branches, each of which is considered a "social science".

Unit I: Economics, political science, human geography, demography and sociology.
Unit II: Humanities, anthropology, archaeology, jurisprudence, psychology, history, and linguistic.
Unit III: Political science, economics, sociology, international politics and scientific methodology.

Suggested Readings:

1. Beteille Andre, " Sociology: Essays in Approach and Method", Oxford University Press.
2. Anthony Giddens, "Sociology", Polity Press.
3. Max Weber, " The Methodology of the Social Sciences", New York: Free Press.
4. E. Durkheim, "The Rules of Sociological Method." London: Macmillan

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO009	ENTREPRENEURSHIP	3L-1T-0P	4	None

Course Objectives

- This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of who the entrepreneurs are and what competences are needed to become an entrepreneur.

Contents:

Unit I-Introduction:

Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

Unit II- Creating Entrepreneurial Venture:

Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Challenges in managing innovation; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial leadership- components of entrepreneurial leadership; Entrepreneurial Challenges; Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection- Patents Trademarks and Copyrights – importance for startups, Legal Acts Governing Business in India.

Unit III-Functional plans:

Marketing plan– for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, pro forma cash budget, funds Flow and Cash flow statements; Pro forma balance sheet; Break Even Analysis; Ratio Analysis.

Unit IV- Entrepreneurial Finance:

Debt or equity financing, Sources of Finance- Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.

Unit V- Enterprise Management:

Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers & acquisitions.

Suggested Readings:

1. Kumar, Arya, “Entrepreneurship: Creating and Leading an Entrepreneurial Organization”, Pearson, India.
2. Hishrich., Peters, “Entrepreneurship: Starting, Developing and Managing a New Enterprise”, Irwin.
3. Taneja, “Entrepreneurship”, Galgotia Publishers.
4. Barringer, Brace R., and R. Duane Ireland, “ Entrepreneurship”, Pearson Prentice Hall. .
5. Hisrich, Robert D., Michael Peters and Dean Shephered, “Entrepreneurship”, Tata McGraw Hill.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO010	Social work	3L-1T-0P	4	None

Course Objective(CO):

- In this course students will learn about various methods of social work, about community organization, social welfare administration, Problems pertaining to Marriage, Family and caste.

Unit 1.Social work

Philosophy and Methods. Social work: Meaning, Objectives, Scope, Assumptions & Values; History of Social work in U.K. U.S.A.and India, philosophy of Social Work. Democratic (Equality, Justice Liberty & Fraternity) and Humanitarian (Human Rights) Matrix.Social works as a profession.

Unit 2. Methods of Social work

Meaning, Scope Principles, Processes (Psychosocial study, Assessments, treatment-goal formulation and techniques), Evaluation, Follow-up and Rehabilitation. Social Groups work: Meaning, Objective, Principles, Skills, Processes (Study, Diagnosis, treatment and evaluation), Programme, Planningand Development, Role of Social group worker, Leadership Development.

Unit 3 Community organization

Meaning, Objective, Principles, Approaches, Roles of Community Organization Worker.

Unit 4 Social Welfare Administration

Meaning Scope, Auspices-Private and Public, Principles, Basic Administrative Processes and Practice decision making communication, planning.organisation, budgeting and finacial control, reporting. Social work Research: Meaning objectives, types, scope, scientific method, Selection and formulation of the problem Research Design Sampling, Sources and Methods of Data Collection, Processing of Data, analysing and interpretation, Report writing. Social Action: Meaning,Scope, approaches (Sarvodays, Antyodaya etc.) and Strategies.

Unit 5 Work in India Problem pertaining to Marriage, Family and caste

Dowry- child Marriage, Divorce, Families with working couples, Disorganised Families, Families with Emigrant Heads of the Households, Gender Inequality, Authoritarian Family structure, Major Changes in Caste systems and problem of casteism. Problems Pertaining of Weaker Sections. Problems of Children, Women Aged. Handicapped and Backward Classes (SCs, STs, and other Backward Classes). Problems of Deviance**:** Truancy Vagrancy and Juvenile Delinquency, Crime, White Colla Crime, Organized Crime,Collective Violence, Terrorism, Prostitution and Sex Related Crimes. Social Vices: Alcohilism. Drug Addiction, Beggary, Corruption and communalism. Problems of Social Structure **:** Poverty, Unemployment, Bonded Labour, Child Labour. Fields of Soclal work India **:** Child Development, Development of Youth, Women's Empowerment, Welfare of aged, Welfare of Physically. Mentally and Social Handicapped, Welfare of backward Classes (Scs, STs and Other Backward Classes) Rural Development Urban Community Development, Medical And Psychiatric Social work, Industrial Social work, Social Security offender Reforms.

Suggested Readings:

1. Rajni Bedi , "Social Work: An Introductory Text Book"**,** New Royal Book Company.
2. Sanjay Bhattacharya, " Social Work: An Integrated Approach", Deep and Deep Pub.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO011	**Intellectual property and Patenting**	**3L-1T-0P**	**4**	**None**

Course Outcome:

The objective of this Course is to provide in-depth knowledge of the laws and process related to Trademarks, Copyrights and other forms of IPs with focus on Patents, the Indian and International Patent filing procedure, drafting patent application and conducting prior art searches. Students will be exposed to the technical, management and legal aspects of IP and Patents.

Course Contents:

UNIT I: Introduction: Historical and philosophical background of patents and other intellectual property, Patent System: the Constitution, Congress, Patent Office (PTO), and courts; Analyzing and understanding judicial opinions

UNITII: Comparative overview of patents, copyrights, trade secrets, and trademarks: Legal fundamentals of patent protection for useful inventions**,** Design and plant patents, Legal fundamentals of copyright protection, Similarity and access, Expression vs. ideas and information, merger, Fair use of copyrighted works (e.g., for classroom use), Contributory copyright infringement, Critical differences between patent and copyright protection, Copyright infringement distinguished from plagiarism, Legal fundamentals of trade-secret protection, Legal fundamentals of trademark protection

UNIT III: Requirements and limitations of patentability: New and useful: (A) The legal requirement of novelty (B) First to invent vs. first inventor to file, The legal requirement of non-obviousness.

UNIT IV: The process of applying for a patent ("patent prosecution"): Anatomy of a patent application, Adequate disclosure, The art of drafting patent claims, Patent searching: (A) Purposes and techniques, Actions for patent infringement, Interpretation of claims, Doctrine of equivalents, Product testing as a possibly infringing use, Doctrine of exhaustion

Suggested Readings:

1. Rines, Robert H., " Create or Perish: The Case for Inventions and Patents", Acropolis.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO012	**Supply Chain Management and Logistics**	**3L-1T-0P**	**4**	**None**

Course objectives(CO):-

- Supply chain management consists of all parties (including manufacturer, marketer, suppliers, transporters, warehouses, retailers and even customers) directly or indirectly involved in fulfillment of a customer. The main objective is to acquaint the students with the concepts and tools of supply chain management and logistics as relevant for a business firm.

Unit I

Introduction: Concept of supply chain management (SCM) and trade logistics; Scope of logistics; Logistic activities – an Overview; Contribution of logistics at macro and micro levels; SCM and trade logistics; Business view of SCM; Concept, span and process of integrated SCM; Demand management – methods of forecasting; Supply chain metrics (KPIs), performance measurement and continuous improvement; Product development Process and SCM; Strategic role of purchasing in the supply chain and total customer satisfaction; Types of purchases; Purchasing cycle.

Unit II

Managing Relationship: Role of Relationship marketing in SCM; Managing relationships with suppliers and customers; Captive buyers and suppliers; Strategic partnerships; Supplier-retailer collaboration and alliances.

Unit III

Focus Areas of Logistics and Supply Chain management: Transportation-Importance of effective transportation system; Service choices and their characteristics; inter-modal services; Transport cost characteristics and rate fixation; In-company management vs. out-sourcing; World sea borne trade; International shipping- characteristics and structure; Liner and tramp operations; Liner freighting; Chartering-Types, principles and practices; Development in sea transportation-Unitization, containerisation, inter and multimodal transport; CFC and ICD. Air transport: Set up for air transport and freight rates; Carriage of Goods by sea -Role and types of cargo intermediaries. Warehousing and inventory management: Reasons for warehousing; Warehousing evaluation and requirements; Warehousing location strategies; Inventory management principles and approaches; Inventory categories -EOQ, LT, ICC; Material management systems and techniques – JIT purchasing, manufacturing and in-bound logistics; Packing and marking; Control and communication.

Unit IV

IT Enabling Logistics and Supply Chain: Technology in logistics – EDI, bar Coding, RFID etc., data warehousing, electronic payment transfers; Business management systems; TRADITIONAL ERP, SPECIAL ERP, MR, DRP, PDM, EIP, CPFR, WMS, TMS; Re-engineering the supply chain- Future directions.

Unit V

Trends and Challenges in logistics and supply chain management: Third party logistic outsourcing –challenges and future directions.

Suggested Readings:

1. Christopher, M., " Logistics and Supply Chain Management", Prentice Hall.
2. Handfield and Nicholas, Jr., "Introduction to Supply Chain Management", Prentice Hall.
3. Jhon J Coyle, C. Jhonand Langley, Brian J Gibs, "Logistics approach to Supply Chain Management", Cengage Learning.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO013	**Organization Development**	**3L-1T-0P**	**4**	**None**

Course Objectives:

- Organization Development is a growing field of Human Resource Management. It has its foundations in a number of behavioral and social sciences.

Contents:

1. Organizational Systems and Human Behaviour - Developing a basic knowledge of how organizattons and groups function as systems; introducing and discussing various theoretical approaches and issues.
2. Interpersonal and Consulting Skills - Increasing effectiveness as a change agent by providing a variety of opportunities in order to increase self-awareness, practice alternative ways of approaching personal and interpersonal problem-solving and develop basic consulting and interviewing skills.
3. Introduction to Organization Development - Introducing some basic theories, models and methods in the field of organization development, especially those relating to the role of consultant and strategies for change.
4. Intervention and Change in Organizations - Consolidating and further developing consulting skills and strategies
5. Action Research Project - Carrying out a change activity in an organization, while also researching the effects and/or the process. This provides participants with an opportunity to consolidate and demonstrate skills and knowledge gained in other units of the course.

Suggested Readings:

1. Mee-Yan Cheung-Judge, Linda Holbeche, “Organization Development: A Practitioner's Guide for OD and HR”, Kogan Page.
2. Lisa Haneberg, “Organization Development Basics (ASTD Training Basics)” , ASTD Press

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO014	**Industrial organisation and managerial economics**	**3L-1T-0P**	**4**	**None**

Course Objectives: This course help students in understanding the basics of management and Industrial organisation.

Contents:

Unit I: Principles of management, General idea, various functions, scope of engineering. Organisation structure, Types, merits and demerits.

Unit II: Plant location and layout, Factors effecting location, types of layout. Production planning and control, Sequence of planning and control of production. Scheduling, routing, despatching., Methods Study, Methods analysis, time study methods of rating.

Unit III: General idea of personnel management, Industrial psychology, job evaluation and monitoring. Business decision making and forward planning. Demand and demand forcasting of production analysis- prices and pricing decision-profit and capital, management. Analysis of inter-industry relation, macro-economic and business.

Suggested Readings:

1. KoutsoyiannisA , " Modern Microeconomics", Palgrave Macmillan.
2. D.N. Dwivedi, " Managerial Economics", S.Chand (G/L) & Company Ltd;
3. Maheshwari., "Managerial Economics", PHI
4. Ruddardutt and K.P.M.Sundharam, " Indian economy", S Chand

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO015	**Global Strategies and Technology**	**3L-1T-0P**	**4**	**None**

Course Objectives

- This subject focuses on the specifics of strategy and organization of the multinational company, and provides a framework for formulating successful and adaptive strategies in an increasingly complex world economy.

Contents:

Globalization of industries, the continuing role of country factors in competition, organization of multinational enterprises, and building global networks.

Analysis of competitive situations from the general management point of view, including fit between key environmental forces and the firm's resources, and changes in these over time. Formulating and implementing strategy based on that analysis. Developing and leveraging a firm's core competencies to gain long-term sustainable advantage.

Suggested Readings:

1. Mike W. Peng, "Global strategy", South-Western College Pub.
2. Pankaj Ghemawat, "Redefining Global Strategy", Harvard Business Review Press
3. Cornelis A. de Kluyver, "Fundamentals of Global Strategy", Business Expert Press.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO016	Engineering System analysis and Design	3L-1T-0P	4	None

Course Objective:

- The students will learn about system definitions and role of system analyst. They will learn about system modeling and design. They will be exposed to System Implementation and Maintenance issues.

Unit 1

System definition and concepts: Characteristics and types of system, Manual and automated systems

Real-life Business sub-systems: Production, Marketing, Personal, Material, finance Systems models types of models: Systems environment and boundaries, Real time and distributed systems, Basic principles of successful systems

Unit 2

Systems analyst: Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst, agent of change.

Various phases of systems development life cycle: Analysis, Design, Development, Implementation, Maintenance

Unit3

Systems Design and modeling:Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ERD diagrams. Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems

Unit 4

User Interfaces – Relational Analysis – Database design – program design– structure chart – HIPO – SSADM – Alternate Life cycles – Prototypes.

Unit 5

System Implementation and Maintenance:Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance, Testing and validation, Systems qualify Control and assurance, Maintenance activities and issues.

Suggested Readings:

1) Haryszkiewycz, “Introduction to Systems Analysis and Design”, PHI .
2) James A Senn, “Analysis and Design of Information Systems”, Tata McGraw Hill .

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO017	**BIOLOGY FOR ENGINEERS**	**3L-1T-0P**	**4**	**None**

Course Objectives:

1. General understanding of organization in biological systems
2. Conceptual knowledge of functioning in biological systems
3. Clarity about relevance of Biology to engineering graduates
4. Understanding human body as a study-model for engineering students
5. Understanding electrical, chemical and magnetic forces, and communication networks in human body.

Contents:

Unit I: Principles of Biology: Form and Function, Modularity and Incremental Changes, Genetic Basis, Competition and Selection, Biological Hierarchies, Biological complexity vs simplicity

Unit II: Biological Responses: Need for Water, Oxygen, Food, Nutrients, Heat Sources and Sinks, Adaptation to their Environments, Waste tolerance, Response to Chemical and Mechanical Stresses, Optimization to Save Energy and Nutrient Resources, **Allometric Relationships from Evolutionary Pressure**

Biology for Engineering Solutions: Systems Approach, Relationships between Engineering and Biology, The Completed Design

Biological Systems and Dynamics: Basic principles, Qualitative and quantitative description of Human Body, Modeling of Human Body: Compartments, Fluid streams, Production sources, The Hemodynamic System, Cheyne-Stokes Respiration,

Neural system: Action Potentials and Ion Channels, Ficks Law, Ohms Law and the Einstein Relation, Cellular Equilibrium: Nernst and Goldman, Equivalent Circuits, Dendrites; **Mathematical Neurodynamics:** Hodgkin, Huxley and the Squid Giant Axon FitzHugh-Nagumo Model, Fixed Points and Stability of a One-Dimensional Differential Equation, Nullclines and Phase Plane, Pitchfork and Hopf Bifurcations in Two Dimensions Excitability, Bioelectric and biomagnetic phenomena and their measurements.

Suggested Readings:

1. T. Johnson, " Biology for Engineers", CRC Press
2. : Michael Small, "Dynamics of Biological system", CRC Press.
3. Johnny T. Ottesen, MS Olufsen, JK Larsen, "Applied Mathematical Models and Human Physiology", Society for Industrial and Applied Mathematics.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO018	Energy, Environment and Society	3L-1T-0P	4	None

Course Objective:
The objective is to aware students about various renewable resources, Basics of energy, environmental Impact of Energy sources. Students will also learn about the role of appropriate Technology in Transformation of Society.

Contents:

Unit 1 Technology and Development
Introduction to Technology, Appropriate Technology, Role of Appropriate Technology in Transformation of Society, Importance of Technology Transfer, Impact of technology on Society.

Unit 2 Energy Basics
Importance of Energy in achieving Maslow's hierarchy of Needs, Human Development Index and Energy Consumption, Current Energy Trends, Demand and Supply of Energy in World and Nepal, Introduction to Global warming, Clean Development Mechanism, and Sustainability Issues, Conventional and Non-Conventional/Renewable Energy Sources,. Conventional Energy Sources: Fossil fuel, Nuclear Energy

Unit 3 Renewable Energy Sources
Solar radiation, Solar thermal energy, Solar Cell (Photovoltaic Technology), Hydropower Water sources and power , Water turbines and hydroelectric plants, Hydro Power Plant Classification (pico, micro, small, medium, large), Wind Energy , Availability of Wind Energy sources, Wind turbines, wind parks and power control, Geothermal Energy, Sources of Geothermal Energy, Uses of Geothermal Energy, .Bio-mass and Bio-energy, Synthetic fuels from the biomass ,Thermo-chemical, physio-chemical and bio-chemical conversion, Bio-fuel cells , Hydrogen Energy and Fuel Cell , Basics of electrochemistry, Polymer membrane electrolyte (PEM) fuel cells, Solid oxide fuel cells (SOFCs) , Hydrogen production and storage.

Unit 4 Environmental Impact of Energy sources

Emission hazard, Battery hazard, Nuclear hazard

Unit 5 Energy Storage

Forms of energy storage, Hybrid vehicles, Smart grid systems, Batteries, Super-capacitors

Suggested Readings:

1) Saxena, A.B., "A Textbook of Energy, Environment, Ecology and Society", New age international

2) Juan Martínez Alier,Klaus Schlüpmann, "Ecological Economics: Energy, Environment, and Society", Basil Blackwel.

SCHEME OF COURSES – M.TECH. (PROCESS CONTROL)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO019	**Public Policy and Governance**	**3L-1T-0P**	**4**	**None**

Course Objective:

- Students will be introduced to Public Policy and administrative governance. They will also learn about Administrative Governance.

Contents:

Unit 1 Introduction to Public Policy and Administrative Governance: Introduction to public policy, econometrics for policy research, policy analysis, economics for public decision making.

Unit 2 Public Bureaucracy in Theory and Practice: Benefit cost analysis, public budgeting, revenue and expenditures, managing and leading public service organisations.

Unit 3 Administrative Governance: The Challenge of Policy Implementation, public and non-profit programme evaluation.

Unit 4 Non-state Actors in Policy-making and Administrative Governance: governance in twenty-first century, Social Diversity and the Question of "Difference" in Policy-making and administrative Governance.

Suggested Readings:

1. John Shields and B. Mitchell Evans, "*Shrinking the State: Globalization and Public administration Reform",* Halifax: Fernwood.
2. Beryl Radin, "Beyond Machiavelli: Policy Analysis Reaches Midlife", Washington, DC: Georgetown University Press.
3. Frank R. Baumgartner, Jeffrey M. Berry, Marie Hojnacki, and David C. Kimball, " Lobbying and Policy Change: Who Wins, Who Loses, and Why", Chicago, IL: University of Chicago Press.
4. Timothy Conlan, Paul Posner, and David Beam, "Pathways of Power: The dynamics of National Policymaking", Washington, DC: Georgetown University press.