UNIVERSITY OF DELHI

NETAJI SUBHASINSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM

SCHEME OF COURSES FOR M.TECH. (MECHATRONICS)

Passed in the meeting of standing committee on Academic matters held on June 3, 2016

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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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, opposing interpretations must be established. Research should not only be confined to redefinition, extension and incremental change. Innovation & creativity should become an epicentre 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.

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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.oracombination 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 twokinds:Core and Elective.

   i. **Core Course (CC)**: Thisis 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 nurturingastudent'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:GradesandGradePoints

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 theexamination.If the student does not want to reappear in an elective subject (that isED, EO*but not CC courses*) then he/she can re-register afresh for a new elective subject.

3. **Non-credit course:** For non creditcourses, '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 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 with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

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$$SGPA(\ _i) = \frac{\sum C_i * G_i}{\sum C_i}$$

Where $C_i$is the number of credits of the i^{th}courseand $G_i$is the grade point scored by the student in the i^{th} course.

ii. TheCGPA is also calculated in the same manner taking into account all the courses under gone by a student overall the semesters of a programme, i.e.

$$CGPA = \frac{\sum C_i * S_i}{\sum C_i}$$

Where 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 shallbe 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. PROGRAMMESTRUCTURE

1. The M.Tech. Mechatronics MT full-time(FT)programmespans 4 semesters, normally completed in 2 years, while M.tech Mechatronics programe MT part-time(PT) spans 6 semesters, normally completed in three years.

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:

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:

MTC**	CC
MTC**	CC
MTD**	Elective
MTD**	Elective
MTD**	Elective
EO***	Open Elective

For IInd semester, the codes are:

MTC**	CC

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MTC**	CC
MTD**	Elective
MTD**	Elective
MTD**	Elective
EO***	Open Elective

For IIIrd semester, the codes are:

MTD**	Elective
MTD**	Elective
MTD**	Elective
MTC**	Seminar
MTC**	Major Project

For IVth semester, the codes are:

MTC**	Dissertation

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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/ without 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. (MT) programme consists of 82creditsCGPA 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 (ES) 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 pro-forma 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.

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 Mecharonics.

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 MTech Course

XII. PROGRAME EDUCATIONAL OBJECTIVE

1. Apply mechanical engineering and electrical engineering knowledge and skills to problems and challenges in the areas of mechatronic engineering.

2. Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.

3. Demonstrate professional interaction, communicate effectively with team members and work effectively on multi-disciplinary teams to achieve design and project objectives.

4. Engage in lifelong learning in their profession and practice professional and ethical responsibility.

XIII. PROGRAME OUTCOME

By the time they graduate, students will be able :

1. to define the problem.
2. to employ the basic mathematical skills needed to solve routine engineering problems.
3. to demonstrate knowledge of electrical circuits and logic design.
4. to implement engineering solutions and techniques to solve design problems
5. to demonstrate knowledge of statics, dynamics and solid mechanics relevant to Mechatronics.

6. to design mechatronic components and systems. 2b to select the appropriate mechatronic device for a given application
7. to design and conduct experiments and analyze data.
8. to apply spreadsheets, computer-based modeling and other computer-based methods to solve mechatronic problems.
9. to communicate through writing with others in the field of mechatronics.
10. to communicate orally with others in the field of mechatronics.
11. to demonstrate team-oriented skills within the field of mechatronics.
12. to identify and evaluate ethical ramifications and professional responsibilities in a variety of situations.
13. to discuss the impact of engineering on society, safety, and the environment in relation to contemporary issues.
14. to exhibit skills for lifelong learning.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

SCHEME SEMESTER-WISE COURSE ALLOCATIONFULL-TIME

M.TECH. MECHATRONICS (FT) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTC01	CC	Fundamentals Of Mechatronics	3	0	2	4	15	15	40	15	15	100
MTC02	CC	Dynamics And Control Systems	3	0	2	4	15	15	40	15	15	100
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
EO***	EO	Open Elective#	-	-	-	4	25	25	50	-	-	100
		TOTAL	18	3	6	24						
			$									

#The LTP Allocation, evaluation scheme and pre-requisites for electives are given in Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

M.TECH. MECHATRONICS (FT) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTC03	CC	Large Scale Systems	3	0	2	4	15	15	40	15	15	100
MTC04	CC	Modelling& Simulation of Mechatronics Systems	3	0	2	4	15	15	40	15	15	100
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective #	-	-	-	4	-	-	-	-	-	100
EO***	EO	Open Elective#	-	-	-	4	25	25	50	-	-	100
		TOTAL	18	3	6	24						
			$									

#The LTP Allocation, evaluation scheme and pre-requisites for electives are given in Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

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M.TECH. MECHATRONICS (FT) SEMESTER III

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTC05	CC	Seminar	0	0	4	2	100	-	-	-	-	100
MTC06	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 Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

M.TECH. MECHATRONICS (FT) SEMESTER IV

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTC07	CC	Dissertation	0	0	-	14	-	-	-	40	60	100
		TOTAL	0	0	-	14						

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SCHEME SEMESTER-WISE COURSE ALLOCATIONPART-TIME

M.TECH. MECHATRONICS (PT) SEMESTER I

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTC01	CC	Fundamentals Of Mechatronics	3	0	2	4	15	15	40	15	15	100
MTC02	CC	Dynamics And Control Systems	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective#	-	-	-	4	25	25	50	-	-	100
		TOTAL	9	1	4	12						
			$									

#The LTP Allocation, evaluation scheme and pre-requisites for electives are given in Table no: 3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

M.TECH. MECHATRONICS (PT) SEMESTER II

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTC03	CC	Large Scale Systems	3	0	2	4	15	15	40	15	15	100
MTC04	CC	Modelling& Simulation of Mechatronics Systems	3	0	2	4	15	15	40	15	15	100
EO***	EO	Open Elective#	-	-	-	4	25	25	50	-	-	100
		TOTAL	9	1	4	12						
			$									

#The LTP Allocation, evaluation scheme and pre-requisites for electives are given in Table no: 3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

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M.TECH. MECHATRONICS (PT) SEMESTER III

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

#The LTP Allocation, evaluation scheme and pre-requisites for electives are given in Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

M.TECH. MECHATRONICS (PT) SEMESTER IV

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

#The LTP Allocation, evaluation scheme and pre-requisites for electives are given in Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

M.TECH. MECHATRONICS (PT) SEMESTER V

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Wightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTC06	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 Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

M.TECH. MECHATRONICS (PT) SEMESTER VI

CODE	TYPE	COURSE OF STUDY	L	T	P	C	EVALUATION SCHEME Percentage (Weightage)					
							Theory			Practical		Total
							CA	MS	ES	Int	Ext	
MTD**	ED	Elective#	-	-	-	4	-	-	-	-	-	100
MTC05	CC	Seminar	0	0	4	2	100	-	-	-	-	100
MTC07	CC	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 Table no:3,4. The coarse code will depend upon student's choice of elective(s).
$ The actual weekly load will depend upon elective(s) chosen by the student.

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TABLE NO: 3 LIST OF DISCIPLINE CENTRIC ELECTIVES						
CODE	**COUSRE OF STUDY**	**PREREQUISITE**	**L**	**T**	**P**	**C**
MTD01	Principles of Electronic Devices	Basics of electrical and electronics	**3**	**1/0**	**0/2**	**4**
MTD02	Sensors and Signal Conditioning	Nil	**3**	**1/0**	**0/2**	**4**
MTD03	Industrial Robotics	Microcontroller	**3**	**1/0**	**0/2**	**4**
MTD04	Microcontroller And Programmable Logic Controllers (PLC)	Nil	**3**	**1/0**	**0/2**	**4**
MTD05	Industrial Electrical And Electronics	Power electronics	**3**	**1/0**	**0/2**	**4**
MTD06	Advanced Sensor Systems And Instrumentation	Electrical and electronics Measurement	**3**	**1/0**	**0/2**	**4**
MTD07	Fluid Power System And Factory Automation	Fundamental of Mechatronics and PLC	**3**	**1/0**	**0/2**	**4**
MTD08	AI Techniques and Applications	Nil	**3**	**1/0**	**0/2**	**4**
MTD09	Power Electronics	Circuit analysis, Electron devices and Electronic circuits, and Differential equations	**3**	**1/0**	**0/2**	**4**
MTD10	Power Electronics & Drives	Basics of Electrical machines and electronics	**3**	**1/0**	**0/2**	**4**
MTD11	Embedded Sensors And System Design	Digital electronics and measurement	**3**	**1/0**	**0/2**	**4**
MTD12	Mechatronics system design	Fundamental of Mechatronics and PLC	**3**	**1/0**	**0/2**	**4**
MTD13	Nano Technology	Applied physics,	**3**	**1/0**	**0/2**	**4**
MTD14	PC based automation	Microcontroller	**3**	**1/0**	**0/2**	**4**
MTD15	Industrial Automation	Basic of Manufacturing Systems	**3**	**1/0**	**0/2**	**4**
MTD16	Computational Techniques For Vibration Analysis And Control	Basic control engineering and measurement	**3**	**1/0**	**0/2**	**4**
MTD17	MEMS	Basics of electrical machines, control, manufacturing	**3**	**1/0**	**0/2**	**4**
MTD18	MEMS and NEMS	Basics of physics, chemistry and electronics	**3**	**1/0**	**0/2**	**4**
MTD19	Design of Hydraulic and pneumatic System	Fundamental of Mechatronics	**3**	**1/0**	**0/2**	**4**
MTD20	Machine tool control and condition monitoring	Sensors and transducer, electrical machine, control system	**3**	**1/0**	**0/2**	**4**
MTD21	Robust control	Control systems	**3**	**1/0**	**0/2**	**4**

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MTD22	Instrumentation & Sensor Technology	Electrical and electronics measurement	**3**	**1/0**	**0/2**	**4**
MTD23	Introduction to Optimization Techniques	Nil	**3**	**1/0**	**0/2**	**4**
MTD24	Signal Processing in Mechatronic Systems	Signals and system	**3**	**1/0**	**0/2**	**4**
MTD25	Fault Detection And Diagnosis	Nil	**3**	**1/0**	**0/2**	**4**
MTD26	Drives And Controls For Automation	Electrical machine/power apparatus, power electronics	**3**	**1/0**	**0/2**	**4**
MTD27	Energy Auditing And Management	Nil	**3**	**1/0**	**0/2**	**4**
MTD28	Evolutionary Computations	Nil	**3**	**1/0**	**0/2**	**4**
MTD29	Fundamentals Of Electrical Machines And Drives	Basic electrical engineering	**3**	**1/0**	**0/2**	**4**
MTD30	Power Quality And Harmonics	Power electronics	**3**	**1/0**	**0/2**	**4**
MTD31	Digital Control Systems	Signal and systems	**3**	**1/0**	**0/2**	**4**
MTD32	Precision Engineering	Measurement and control system	**3**	**1/0**	**0/2**	**4**
MTD33	Reliability Engineering	Nil	**3**	**1/0**	**0/2**	**4**
MTD34	Real Time Systems And Software Development	Nil	**3**	**1/0**	**0/2**	**4**
MTD35	Concepts In Electronics Engineering	Nil	**3**	**1/0**	**0/2**	**4**
MTD36	Machine Vision	Analog and digital electronics	**3**	**1/0**	**0/2**	**4**

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SCHEME OF COURSES – M.TECH. (MECHATRONICS)

TABLE NO : 4 LIST OF OPEN ELECTIVES EO***							
LTP Allocation			**Evaluation Scheme**				
L	**T**	**P**	**CA**	**MS**	**ES**	**Int**	**Ext**
3	**1**	**0**	**30**	**20**	**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. (MECHATRONICS)

COURSE CONTENTS OF CORE COURSES

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTC01	FUNDAMENTALS OF MECHATRONICS	3L-0T-2P	4	None

Course Outcome:
To expose the learner to the fundamentals of hydraulic and pneumatic power control and their circuits with industrial applications.

Course Contents:

UNIT I - HYDRAULIC COMPONENTS: Introduction to fluid power system-Pascal's Law- Hydraulic fluids- Hydraulic pumps- Gear, Vane and Piston pumps- Pump Performance- Characteristics and Selection-actuators- valves-pressure control- flow control and direction control valves- Hydraulic accessories- Hydraulic Accumulator.

UNIT II - PNEUMATIC COMPONENTS: Introduction to Pneumatics- Compressors- types-. Air treatment-FRL unit- Air dryer- Control valves- Logic valves-Time delay valve and quick exhaust valve- Pneumatic Sensors – types- characteristics and applications.

UNIT III - FLUID POWER CIRCUITS: Circuit Design Methodology- Sequencing circuits- Overlapping signals- Cascade method- KV Map method-Industrial Hydraulic circuits- Double pump circuits- Speed control Circuits- Regenerative circuits- Safety circuits- Synchronizing circuits- Accumulator circuits.

UNIT IV - ELECTRO- PNEUMATICS AND HYDRAULICS: Relay, Switches- Solenoid- Solenoid operated valves- Timer- Counter- Servo and proportional control- Microcontroller and PLC based control- Design of electropneumatic and hydraulic circuits

UNIT V – PLC: Evolution of PLC's - Sequential and programmable controllers - Architecture-Programming of PLC - Relay logic - Ladder logic - Gates, Flip flops and Timers.

UNIT VI - COMMUNICATION IN PLC's: Requirement of communication networks of PLC - connecting PLC to computer - Interlocks and alarms - Case study of Tank level control system and Sequential switching of motors.

Suggested Readings:

1. John Pippenger, "Hicks, Industrial Hydraulics", McGraw Hill International Edition
2. AndrewParr, "Hydraulics and pneumatics", Jaico Publishing House.
3. Perter Croser, Frank Ebel "Fundamentals of Pneumatics", FESTO
4. Petrezeulla, "Programmable Controllers", McGraw Hill
5. Hughes .T, "Programmable Logic Controllers", ISA Press
6. Curtis D. Johnson "Process Control Instrumentation" Prentice Hall
7. Anthony "Esposito, Fluid Power with applications", Prentice Hall
8. Majumdar .S.R, "Oil Hydraulics", Tata McGraw Hill
9. Majumdar S.R, "Pneumatic systems - principles and maintenance", Tata McGraw Hill

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTC02	Dynamics And Control Systems	3L-0T-2P	4	None

Course Outcome:

- To understand dynamics, design and analysis of control systems to meet the desired Specifications

Course Contents:

UNIT I - SYSTEM REPRESENTATION AND MODELLING

Introduction and need for Control Systems with examples – Open loop and Closed loop systems – Transfer Function Model – State Space Model – Mathematical Modelling of Mechanical, Electrical, Pneumatic and Hydraulic systems – Block Diagram reduction – Signal flow graph.

UNIT II - DESIGN OF FEEDBACK CONTROL SYSTEM

Feed back systems – Block Diagram – Definition of Process variable, Set-point, Manipulated variable and Final control element with examples – Characteristics of on-off, P, PI, PD and PID Controllers – Implementation issues of PID Controller – Modified PID Controller – Tuning of controllers.

UNIT III - TIME DOMAIN ANALYSIS

Time response of First & Second order systems – Time domain specifications - steady state errors and error constants – Routh Hurwitz criterion – Root locus – Root locus approach to control system design – Lead, Lag, Lag-Lead Compensation using time domain analysis.

UNIT IV - FREQUENCY DOMAIN ANALYSIS

Bode Plot – Polar Plot – Nyquist stability criterion – Stability analysis – Experimental determination of Transfer Functions – Control system design using Frequency domain analysis - Lead, Lag, Lag-Lead Compensation using frequency domain analysis.

UNIT V - CASE STUDY ON CONTROL AND ANALYSIS OF SERVO MOTOR

Servo motor – Mathematical Modelling of Servo Motor – Analysis of Servo motor system using Routh Hurwitz criterion, Root locus, Bode Plot, Polar Plot and stability analysis – Implementation of P, PI ,PD and PID controllers for servo motor and analysis.

Suggested Readings:

1. K.ogata, :Modern Controls Engineering " Prentice Hall of India Pvt. Ltd.,
2. B.C. kuo, "Automatic Control Systems", Prentice Hall of India Pvt. Ltd.
3. I.J.Nagrath and Gopal. "Control System Engineering", New Age International (P) Ltd.
4. A. NagoorKani, "Control Systems", RBA publications (P) Ltd.
5. M.Nakamura .S.Gata &N.Kyura, "Mechatronic servo system control", Springer.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTC03	Large Scale Systems	3L-0T-2P	4	None

Course Outcome:

- To understand dynamics, design and analysis of control systems to meet the desired Specifications

Course Contents:

UNIT I - L.S.S. Modelling: Time Domain

Introduction, Aggregation methods, exact and model aggregation by continued fraction, **chained** aggregation descriptive variables approach, descriptive variable systems, solvability and conditionality, time invariance, shuffle algorithm.

UNIT II - L.S.S. Modelling - Frequency Domain

Introduction, Moment matching, Pade approximation, Routh approximation, continued fraction method, error minimization methods, mixed methods and unstable systems, Pade model method, Pade-Routh method, multi input and multi output systems, reduction, matrix continued fraction method, Model continued fraction method, Pade model method, frequency comparison method.

UNIT III - Time Scales and Singular Perturbations

Introduction, problem statement and preliminaries, numerical algorithm, basic properties, relation to model aggregation, feedback control design, singularly perturbed linear systems, fast and slow sub systems, eigenvalue distribution, approximation to time scale approach, system properties, design of optimal controllers, fast and slow controllers, lower order controls.

UNIT IV - Stable Routh –Pade Model Reduction of Interval systems

Introduction, Interval Routh table computation, Stable Routh-Pade model reduction of interval system: the Pade approximation, Kharitonov robust stability theory, problem formulation, moment matching in the stable Routh-Pade model reduction interval systems, stable reduction of interval denominator using kharitonov polynomials, the procedure for stable Routh-Pade model reduction of interval systems; numerical examples related to study.

Suggested Readings:

1. Mohammad Jamshidi, "'Large Scale Systems Modelling and Control", Elsevier Science Ltd
2. Magdi S. Mohamoud and Madan G. Singh, "Large Scale Systems Modelling', North Hollard (Series in systems science and engineering.
3. Prashant Shingare, B.Bandyopadhyay, H.L. Abhyankar, "Model Reduction Techniques using Interval Analysis and Optimization with control system applications", VDM Verlag.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTC04	**Modelling & Simulation of Mechatronics Systems**	3L-0T-2P	4	None

Course Outcome:

- To understand modelling and simulation of mechatronics systems to meet the desired specifications

Course Contents:

UNIT I - Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.

UNIT II - Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

UNIT III - Modelling and Simulation of Practical Problems:

- Pure mechanical models
- Models for electromagnetic actuators including the electrical drivers
- Models for DC-engines with different closed loop controllers using operational amplifiers
- Models for transistor amplifiers

Suggested Readings:

1. V. Giurgiutiu and S. E. Lyshevski, "Micromechatronics: Modeling, Analysis, and Design with MATLAB", Chemical Rubber Company (CRC).
2. L. Ljung, T. Glad, "Modeling of Dynamical Systems", Prentice Hall Inc.
3. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "System Dynamics: A Unified Approach", John Wiley & Sons Inc.
4. G. Gordon, "System Simulation", Prentice Hall India

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

COURSE CONTENTS OF DISCIPLINE CENTRIC ELECTIVES

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD01	Principles Of Electronic Devices	3L-0T-2P	4	None

Course Outcome:
On completion of the course, the students will be able to

- acquire the knowledge of analog and digital devices
- Understand the wide applications of these devices

Course Contents:

UNIT I: Review Semiconductor devices: Two terminal devices – BJT, JF ET, MOSFET, Four terminal devices, SCR, DIAC, TRIAC – Photo devices:- Photo diode – Photo transition, LED, LCD.

UNIT II: Amplifier – Transistor as an amplifier, BJT, FET amplifier (qualitation study) – single stage, multistage Power Amplifiers – class A, B, C and D Amplifiers.

UNIT III: Operational amplifiers - Introduction op-amp, Specification and characteristics, Application – constant gain, voltage summing, voltage Buffer, Instrumentation circuits, Active Filters.

UNIT IV: Introduction to computing – Number, system and code conversion, Logic gates – Boolean algebra – Combinational circuit design, Sequential circuit – Flip flops – RS, JK, T,D, Counters, Shift registers.

UNIT V: Qualitative Study & Interfacing Concepts - Decoder, Encoder, MUX, DEMUX, Memories – RAM, ROM, PROM, EPROM, EEPROM, Programmable logic devices.

Suggested Readings:

1. Robert L Boylested, "Electronic devices & Circuit theorem", Pearson Education
2. Floyd, "Digital Fundamental, Pearson Education
3. Floyd, "Electronic Devices", Pearson Education
4. Albert Paul Malvino, "Electronic Principle", Tata McGraw Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD02	Sensors And Signal Conditioning	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on various types of sensors and transducers for Automation in Mechatronics Engineering.

Course Contents:

UNIT I INTRODUCTION

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types

UNIT II MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Brush Encoders, Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro –Microsyn , Accelerometer.,– GPS, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR)

UNIT III FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load CellMagnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall effect– Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric, Temperature – IC, Thermistor, RTD, Thermocouple,

UNIT V SIGNAL CONDITIONING

Need for Signal Conditioning – DC and AC Signal conditioning – Filter and Isolation Circuits – Operational Amplifier Specifications, Characteristics and Circuits – Voltage and Current Amplifiers – Transmitting Circuits – Fundamentals of Data Acquisition System.

Suggested Readings:

1. Patranabis D.,"Sensor and Actuators", Prentice Hall of India (Pvt) Ltd.
2. Ernest O. Doeblin, "Measurement system, Application and design" Tata McGraw Hill Publishing Company Ltd.,
3. Bradley D.A., and Dawson, Burd and Loader, "Mechatronics", Thomson Press India Ltd.
4. RenganathanS., "Transducer Engineering", Allied Publishers (P) Ltd.
5. Bolton W., Mechatronics, Thomson Press.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD03	Industrial Robotics	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge in the area of mechanical design, sensors and programming of industrial robots.

Course Contents:

UNIT I INTRODUCTION

Types of Industrial Robots, definitions – classifications based on work envelope – Generations configurations and control loops, co-ordinate system – need for robot – basic parts and functions – specifications.

UNIT II MECHANICAL DESIGN OF ROBOT SYSTEM

Robot motion – Kinematics of Robot motion – Direct and Indirect kinematics Homogeneous transformations – linkages and joints – mechanism – method for location and orientation of objects –drive systems – end effectors – types, selection, classification and design of grippers – gripper force analysis.

UNIT III SENSORS

Functions of Sensors – Position and proximity's sensing – tactile sensing – sensing joint forces –vision system– object recognition and image transformation – safety monitoring sensor systems –image analysis – application of image processing.

UNIT IV ROBOT PROGRAMMING & AI TECHNIQUES

Types of Programming – Teach pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

UNIT V ROBOTIC WORK CELLS AND APPLICATIONS OF ROBOTS

Robotic cell layouts – Inter locks – Humanoid robots – Micro robots – Application of robots in surgery, Manufacturing industries, space and underwater.

Suggested Readings:

1. Groover.M.P., "Industrial Robotics, technology, programming and application", Mc-Graw Hill book and co.
2. Fu.K.S ,Gonzalac R.C ,Lee C.S.G, "Robotics Control, sensing ,vision and intelligence", Mc- Graw Hill book co.
3. YoramKoren , "Robotics", McGraw Hill.
4. Janakiraman P.A. "Robotics and Image Processing", Tata McGraw Hill.
5. Saeed B.Niku, "Introduction to Robotics , Analyses , Systems, Applications", Prentice Hall Pvt Ltd.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD04	**Microcontroller And Programmable Logic Controllers (PLC)**	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To understand the programming interfacing and applications of various microcontrollers and programmable logic controller.

Course Contents:

UNIT I INTRODUCTION TO MICRO CONTROLLER: Microprocessors and Microcontrollers – CISC and RISC - Fundamentals of Assembly language Programming – Instruction to Assembler – C Programming for Microcontrollers – Compiler and IDE –Introduction to Embedded systems - Architecture 8051 family - PIC 18FXXX – family – Memory organization

UNIT II PROGRAMMING OF 8051 MICROCONTROLLER: Instruction set – Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial communication of 8051.

UNIT III PROGRAMMING OF PIC18FXXX MICROCONTROLLER: Instruction set – Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial communication,CCP, ECCP PWM programming of PIC18FXXX.

UNIT IV PERIPHERAL INTERFACING: Interfacing of Relays, Memory, key board, Displays – Alphanumeric and Graphic, RTC, ADC and DAC, Stepper motors and DC Motors, I2C, SPI with 8051 and PIC family

UNIT V PLC PROGRAMMING: Fundamentals of programmable logic controller – Functions of PLCs – PLC operations – Evaluation of the modern PLC – Memory– Selection of PLC – Features of PLC – Architecture – Basics of PLC programming – Developing Fundamental wiring diagrams – Problem solving using logic ladder diagrams – communication in PLCs – Programming Timers – Programming counters – Data Handling.

Suggested Readings:

1. Muhammad Ali Mazidi and Janice GillispicMazdi, “The 8051 Microcontroller and Embedded Systems” Pearson Education, Inc.
2. John B. Peatman, “PIC Programming”, McGraw Hill International, USA.
3. John B. Peatman, “Design with Micro controllers”, McGraw Hill International.
4. Kenneth J. Aylala, “The 8051 Micro controller, the Architecture and Programming applications”, Delmar Learning.
5. James W. Stewart,“The 8051 Micro controller hardware, software and interfacing, regents **Regents**/Prentice Hall.
6. Frank D. Petro Zella, “Programmable Logic Controller” McGraw – Hill Publications.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD05	Industrial Electrical and Electronics	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

1. Know about basic electrical engineering along with machines application in micro grid.
1. Know about different electronics and power electronics devices applications.
2. Know about different controllers and their applications.

Course Contents:

UNIT-I: Basic Electrical Engineering, AC & DC Motor characteristics, Speed controls, Starting principles, Selection of proper motors for various applications.

Special Purpose Electrical Machines:- Induction generators self excitation requirements, steady state analysis, voltage regulation, different methods of voltage control, application to mini and micro hydel systems.

UNIT-II: Doubly fed induction machines:- control via static converter, power flow, voltage/frequency control (generation mode), application to grid connected wind and mini/micro hydel systems.

Switched Reluctance Motor: Construction, operating performance, control and applications. Brushless DC Machines: construction operation, performance, control and applications.

UNIT-III: Linear Machines:- Linear Induction Machines and Linear Synchronous Machines. Construction, operation, performance, control and applications. Application of permanent magnets in electrical machine:-structure, magnetic materials used, types of motors e.g. PMDC and PM Synchronous Machine, control and applications. Recent developments in electrical machines.

UNIT-IV: Basic Electronics, Diodes, Transistor configurations, SCR Controls, FET, UJT, A/D Conversion, D/A Conversion, Optoelectronic devices: photo diode/transistor, LDR, LED and LCD and PLASMA displays, opto-coupler, opto-interrupter, high speed detectors – PIN and avalanche photo diodes, DC Power Supplies, AC Power Supplies, Special operational amplifiers, Timing and counting circuits

UNIT-V: Digital Control Theory :- Basic Digital concepts, Structure of a computer controlled system. Review of Z-transform. Computation of time response of Discrete Data system.BillnearTransformation.Wplane, prewar ping, inverse transformation.Design of discrete controllers. Z-domain compensation, wplane compensation, state variable feed back, deadbeat controller sampled data version of PID controllers. Effect of Data Digitization.Effect of finite word size, limit cycle determination. Programmable logic devices: PLA, PLD, CPLD, FPGA and its application.

Suggested Readings:

1. P. S. Bimbra, "Electrical Machines", Khanna
2. P. S. Bimbra, "Power Electronics", Khanna
3. Sedra Smith, "Micro Electronics", Oxford University Press

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD06	**Advanced Sensor Systems and Instrumentation**	**3L-0T-2P**	**4**	**None**

Course Outcome:

- On completion of this course the students will be able to Identify the most suitable method of sensing and transduction for an application design an instrumentation and associated data acquisition system

Course Contents:

UNIT I: Basic Concepts of Measurements and characteristics of an Instrumentation System: System configuration – Problem analysis – Basic characteristics of measuring devices – Calibration - Generalized measurements – Zero order, First order, Second order system – Dead time element.

UNIT II: Sensors and Transducers – 1 : Electromechanical sensors – Resistance type – Potentiometer – Strain gauge – Resistance thermometer – RTD – Inductance type – Capacitance type – Piezo Electric type.

UNIT III: Sensors and Transducers –2 : Magnetic sensors – NMR – MRI – Fiber optic sensors –Opto electronic sensors – CCD – Digital transducers.

UNIT IV: Analog and Digital Instrumentation : Operational Amplifiers – Signal generation – Signal processing – Filtering and signal analysis.

UNIT V: Data Acquisition, Conversion, Transmission and Processing : Signal Conditioning of the inputs – Single channel and Multichannel data acquisition – Data conversion – Multiplexers – Sample and hold circuits – Data transmission systems – Pulse code formats – Modulation techniques – Telemetry system.

Suggested Readings:

1. Nubert H.K.P, “Instruments Transducers” , The Clarendon Press
2. C.S. Rangan, G.P. Sarma, V.S.V. Mani “Instrumentation devices and system”, Tata McGraw Hill.
3. Ernest . O. Doebelin ,”Measurement System Application & Design”, Tata McGraw Hill
4. Oliver F.G, “Practical Instrument Transducers”, Pitman Publishing Co.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD07	Fluid Power System And Factory Automation	3L-0T-2P	4	None

Course Outcome:

- On completion of this course the students will be able to acquire knowledge of the applications of fluid power in various engineering fields work with PLC and understand its application in industry.

Course Contents:

Unit I Introduction to Fluid Power

Definition- Hydraulics Vs Pneumatics – ISO symbols-Application –Pascal's Law-Transmission and multiplication of force-Basic properties of hydraulic fluids- static head pressure-pressure loss – Power- absolute pressure and Temperature- gas laws- vacuum hydraulic power supply source- pneumatic power supply source.

Unit II Control Components and Basic Circuits

Cylinders-accumulators –FRL-Directional control Valves- Pressure control valves-Flow control Valves-electronic control components- DCV controlling single acting, double acting cylinder-counter balance circuit-Fail safe circuit-AND and OR valve circuit-regenerative circuit-meter in and meter out circuit-pressure intensifier circuit-accumulator circuits etc.

Unit III Design of Fluid power circuit

Design method consideration for sequential circuits-intuitive circuit design method-cascade method- sequential logic circuit design using KV method- compound circuit design-step counter design

Unit IV Factory Automation

Introduction- automation principle and strategies-basic elements of an automated system advanced automation function-levels of automation-automation and control techniques continuous Vs discrete control- introduction to control component using PLC

Unit V Programmable Logic controller:

Introduction-architecture-hardware components-Basics of PLC programming-programming timers-programming counters-master and jump controls-Data manipulation instructions

Suggested Readings:

1. James L.Johnson, "Introduction to Fluid power" Delmar Thomson Learning inc.
2. Antony Esposito, "Fluid power system and control", Prentice hall.
3. Peter Rohner, "Fluid power logic circuit design", The Macmillan press.
4. M.P Groover, "Automation production systems and cam", Prentice hall.
5. D. A. Bradley, D.Dawson, N.C. Burd, A.J. Loader, "Mechatronics", Nelson Thrones.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD08	AI Techniques and Applications	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on AI and its applications in engineering field.

Course Contents:

UNIT I Artificial Intelligence: Definition, problem solving methods, searching techniques, knowledge representation, reasoning methods, predicate logic, predicate calculus, multivalue logic.

UNIT II Fuzzy Logic: Crisp sets, fuzzy sets, fuzzy set operations, properties, membership functions, measures of fuzziness, fuzzification and defuzzification methods, fuzzy relations, operation on fuzzy relations, fuzzy numbers and arithmetic, fuzzy implications, approximate reasoning, systems based on fuzzy rules, fuzzy inference. Application of fuzzy-logic to engineering problems, Fuzzy Control Systems, fault diagnosis etc.

UNIT III Artificial Neural Network: Introduction,Biological foundation, mathematical model of biological neuron, types of activation function, feed-forward and feedback ANN models.

UNIT IV Learning Paradigms: Supervised and unsupervised learning, learning rules, single layer and multilayer perceptron model, error back propagation learning algorithm, pattern classification, clustering, Kohonen self-organizing feature map, radial basis function network, support vector machines, Hopfield network, Associative memory and BAM, applications of ANN models to engineering problems.

UNIT V Evolutionary Techniques:Introduction and concepts of genetic algorithms and evolutionary programming

UNIT VI Hybrid Systems: Neuro-fuzzy systems, adaptive neuro-fuzzy inference system, evolutionary neural networks, fuzzy evolutionary systems, Neuro-Genetic, Genetic-Fuzzy systems

Some Practical applications

Suggested Readings:

1. NP Padhy , “Artificial Intelligence and Intelligent Systems”, Oxford University Press.
2. Rajasekaran S. and Pai G.A.V., “Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications”, PHI.
3. Lin C. and Lee G., "Neural Fuzzy Systems", Prentice Hall International Inc.
4. Goldberg D.E. “Genetic Algorithms in Search Optimization & Machine Learning”, Addition Wesley Co.
5. Kosko B., "Neural Networks & Fuzzy Systems A dynamical systems approach to machine intelligence”, Prentice Hall of India.
6. Ronald R. Yager and Dimitar P. Filev, John, “Essentials of Fuzzy Modeling and Control” Wiley & Sons Inc.
7. T. Terano K Asai and M. Sugeno, “Fuzzy System Theory and its applications”, Academic Press.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD09	Power Electronics	3L-0T-2P	4	None

Course Outcome:

- This course prepares students to work professionally in the area of power and power related fields.
- Students will have good understanding of the basic principles of switch mode power conversion
- Students will be able to apply knowledge of mathematics and engineering, and identify formulas to solve power and power electronics engineering problems.
- Students will be able to choose design appropriate power converter topologies.

Course Contents:

UNIT I: Power semiconductor switches: SCRs - series and parallel connections, driver circuits, turn-on characteristics, turn off characteristics.

UNIT II: AC to DC converters: Natural commutation, single phase and three phase bridge rectifiers, semi controlled and fully controlled rectifiers, dual converters, inverter operation.

UNIT III: DC to DC converters: Voltage, Current, load commutation, thyristor choppers, design of commutation elements, MOSFET/IGBT choppers, AC choppers.

UNIT IV: DC to AC converters: Thyristor inverters, McMurray-Mc Murray Bedford inverter, current source inverter, voltage control, inverters using devices other than thyristors, vector control of induction motors.

UNIT V: AC to AC converters: Single phase and three phase AC voltage controllers, integral cycle control, single phase cyclo-converters - effect of harmonics and Electro Magnetic Interference (EMI).

UNIT VI: Applications in power electronics: UPS, SMPS and Drives.

Suggested Readings:

1. Rashid M. H, *Power Electronics - Circuits, Devices and Applications*, 4th Edition, Prentice Hall, New Delhi, 2013.
2. Dubey G. K, Doradla S.R, Joshi and Sinha R.M, *Thyristorised Power Controllers*, New Age International Publishers, New Delhi, 2010.
3. John G. Kassakian, *Principles of Power electronics*, Addison Wesley, 1991

Reference Books

1. VedamSubramanyam K, "Power Electronics", New Age International Publishers.
2. Mohan, Undeland and Robbins, Power Electronics: Converters, Applications, and Design", John Wiley and Sons.
3. Joseph Vithyathil, "Power Electronics", McGraw Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD10	**Power Electronics & Drives**	3L-0T-2P	4	None

Course Outcome:

- On completion of this course the students will be able to design and control various drives and motors develop a real time controller for various process applications.

Course Contents:

UNIT I Introduction: Introduction to power electronics – Power electronics versus linear electronics- review of thyristers– power FETS – turn on and off circuits – Microprocessor based firing circuits – series and parallel operation –protection circuits – design of snubber circuits – ratings and protection

UNIT II Converters and inverters: Analysis of half controlled and fully controlled converters – dual converters – Analysis of voltage source and current source – Current source and series converters

UNIT III Industrial Motor Control: Methods of controlling speed – Induction and DC Motor controls- use of Microcontroller for speed control – Feedback and Feed forward control – Step-up and step-down choppers – use of choppers - Frequency converters and cyclo converters

UNIT IV Relays, Heat and Welding: Electronic relays – operating principles – torque production types – induction and dielectric heating – effect of frequency power requirement – Resistance welding, principle and control – timing sequence Analysis and design of switched mode power supplies – UPS

UNIT V Process Controllers: Elements of process control – process characteristics – ON – OFF control – Proportional and Derivative control – electronic controllers – pneumatic controllers – temperature, flow and pressure control- voltage regulators – principle of digital control.

Suggested Readings:

1. R. Ralph Benediet and Nathan Weiner, “Industrial electronics circuits and applications”, Prentice Hall of India.
2. P.C Sen , “Principles of Electric Machines and Power electronics” – John Wiley & Sons Inc.
3. Harrott , P, “Process Control”, Tata McGraw Hill.
4. Joseph Vithayathil, “Power electronics: Principle and Applications”, McGraw Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD11	Embedded Sensors and System Design	3L-0T-2P	4	None

Course Outcome:
COURSE OUTCOME

Upon completion of this course the student shall be able to:

- Understand and to apply a design methodology for dedicated computer-based System
- Appreciate the considerations of design-specification , technological choice, the Development, maintenance, extensibility and also the importance of extensibility and also the importance of electromagnetic compatibility
- Comprehend the fundamental building blocks of such systems (sensors, actuators, Signal conditioning electronics, processors, interfaces AND SOFTWARE DESIGN & Construction techniques) and their inter-relationships
- To demonstrate practical competence in these areas

Course Contents:

UNIT I: Introduction: Embedded computing - characteristics of embedded computing applications - Embedded system design challenges- constraint - driven - IP - based design - hardware- software co-design

UNIT II: Development Environment: The Execution Environment - Memory Organization - System Space- Code space - data space - Unpopulated Memory Space - I\P Space- system Start-up- Interrupt Response Cycle – Function CALLS AND Stack Frames - Run - Time Environment - Object Placement.

UNIT III: Embedded Computing Platform: CPU bus - memory devices - I\O devices- component interfacing- designing with microprocessors - development and debugging - design example- Design patterns - dataflow graphs - assembly and linking - basic compilation techniques - analysis and optimization

UNIT IV: Distributed Embedded System Design: Inter- process communication - signals - signals in UML - shared memory communication - accelerated design - design for video accelerator - networks for embedded systems - networks based design - Internet enabled systems

UNIT V: Design Techniques: Design methodologies and tools - design flows - designing hardware and software components - requirement analysis and specification - system analysis and architecture design – system integration- structural and behavioral description- case studies.

Suggested Readings:

1. Wayne Wolf, "Computers as Components, Principles of Embedded Computer Systems Design", Morgan Kaufman publishers.
2. Jean J. Labrosse, "Embedded system Building blocks; complete and ready-to-use modules in C" CRC Press.
3. Arnold S.Berger, "Embedded Systems Design; an Introduction to Processes, Tools and Techniques", CRC Press.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD12	Mechatronics System Design	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge in the area of system design in an integrated approach.

Course Contents:

UNIT I INTRODUCTION

Mechatronic systems – Key elements – Mechatronic design process – Application types – Interfacing issues – Man Machine Interfaces – Safety features – optimization of Mechatronic design – Fault diagnosis.

UNIT II SYSTEM MODELLING AND IDENTIFICATION

Mathematical models – Block diagram modelling – Analogy approach – Impedance diagrams – Models for Electrical, Mechanical, Electro-mechanical and Fluid systems – System Identification – Least square method-Closed loop identification – joint input/output identification – State estimators – Model Validation

UNIT III SIMULATION

Simulation basics – Probability concepts in simulation – Discrete event simulation – Simulation Methodology – Queuing system model components – Continuous system modelling – Monte Carlo simulation – Analysis of simulation results – Simulation life cycle.

UNIT IV CASE STUDY ON BASIC SYSTEMS

Mass-Spring-Oscillation and Damping system – Position Control of Permanent magnet DC motor using Hall sensor and optical encoder – Auto-control system for Green House Temperature – Transducer Calibration system – Strain Gauge Weighing system – Solenoid Force-Displacement Calibration system.

UNIT V CASE STUDY ON ADVANSED SYSTEMS

Automatic Washing Machine – Hard Drive control – Auto-focusing in Digital Cameras – Active suspension in vehicles – Visual Servoing models – Thermal cycle fatigue of a Ceramic plate – pH Control system – De- icing temperature control system – Skip control of a CD player – Simulation of Rocket thrust control – Time delay Blower.

Suggested Readings:

1. Devadas Shetty, Richard A.Kolkm, "Mechatronics system design, PWS publishing company.
2. Bolton, "Mechatronics – Electronic control systems in mechanical and electrical engineering", Addison Wesley Longman Ltd., 2009.
3. Brian morriss, "Automated manufacturing Systems – Actuators Controls, sensors and Robotics", McGraw Hill International Edition.
4. Bradley, D. Dawson, N.C.Burd and A.J. Loader, "Mechatronics: Electronics in product and process", Chapman and Hall, London.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD13	NANO Technology	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To inspire the students to expect to the trends in development and synthesizing of nano systems and measuring systems to nano scale.

Course Contents:

UNIT I OVER VIEW OF NANOTECHNOLOGY: Definition – historical development – properties, design and fabrication Nanosystems, working principle, applications and advantages of nanosystem.Nanomaterials – ordered oxides – Nano arrays – potential health effects

UNIT II NANODEFECTS, NANO PARTILES AND NANOLAYERS : Nanodefects in crystals – applications – Nuclear Track nano defects. Fabrication of nano particles – LASER ablation – sol gels – precipitation of quantum dots. Nano layers – PVD, CVD, Epitaxy and ion implantation – formation of Silicon oxide- chemical composition – doping properties – optical properties.

UNIT III NANOSTRUCTURING : Nanophotolithography– introduction – techniques – optical – electron beam – ion beam – X-ray and Synchrotron – nanolithography for microelectronic industry –nanopolishign of Diamond – Etching of Nano structures – Nano imprinting technology – Focused ion beams - LASER interference Lithography nanoarrays–Near-Field Optics - case studies and Trends

UNIT IV SCIENCE AND SYNTHESIS OF NANO MATERIALS

Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes – Solid carbon source based production techniques –Gaseous carbon source based production techniques – Diamond like carbon coating. Top down and bottom up processes.

UNIT V CHARACTERIZATION OF NANO MATERIALS : Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

Suggested Readings:

1. Tai – Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill.
2. Fahrner W.R., “Nanotechnology and Nanoelectronics”, Springer (India) Private Ltd.
3. Mark Madou , Fundamentals of Microfabrication, CRC Press.
4. Norio Taniguchi, “Nano Technology”, Oxford University Press.
5. Mohamed Gad-el-Hak, “MEMS Handbook”, CRC press.
6. Waqar Ahmed and Mark J. Jackson, “Emerging Nanotechnologies for Manufacturing”, Elsevier Inc.

7. Sami Franssila, "Introduction to Micro fabrication", John Wiley & sons Ltd.
8. Charles P Poole, Frank J Owens, "Introduction to Nano technology", John Wiley and Sons.
9. Julian W. Hardner, "Micro Sensors, Principles and Applications", CRC Press.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD14	PC Based Automation	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on architectural information about PC as a hardware for controllers.

Course Contents:

UNIT I COMPUTER BASICS AND COMMUNICATION PROTOCOLS: Basic Computer Architecture – Components of a PC – Serial and Parallel Communications – Parallelport – OSI Model – RS232, USB, ISA, PCI, PXI, PCI Express, GPIB Protocols.

UNIT II NETWORK PROTOCOLS: LAN, WAN and MAN Networks – RS485, RS 422, LXI Protocols – Modbus – Field bus – Ethernet –CAN bus – SCADA and DCS.

UNIT III DATA ACQUSITION SYSTEMS: Continuous and Discrete signals – Sampling theorem – Quantization – Sampling and Hold – ADC –DAC – Resolution and Sampling Frequency – Multiplexing of input signals – Single ended anddifferential inputs – Sampling of Multi-channel analog signals – Concept of Universal DAQ card –Timer & Counter and analog output in Universal DAQ card.

UNIT IV PROGRAMMING TECHNIQUES: Algorithm – Flowchart – Variables & Constants – Expressions – Data types – Input output operations– Conditional Statements – Looping – Sub-programs/Functions – Arrays, Structures and Classes –Inheritance – Polymorphism – Debugging.

UNIT V GRAPHICAL PROGRAMMING: GUI – Graphical Programming – Data Flow techniques – Processing Data in GP – Loops andStructures – Event based & Schedule based operations – Global and Local Variables – File I/Ooperations – Parallel processing of data – Virtual Instrument and control – VISA & SCPI.

Suggested Readings:

1. Morris Mano M., "Computer System Architecture", Prentice Hall of India.
2. John P. Hayes, Computer Architecture and Organization, McGraw Hill International.
3. William Stallings, "Computer Organization and Architecture", Prentice Hall of India.
4. Krishna Kant,"Computer based Industrial Control", Prentice Hall of India.
5. Gary Johnson, "LabVIEW Graphical Programming", McGraw Hill
6. Sanjeev Gupta, "Virtual Instrumentation using Labview" Tata McGraw

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD15	**Industrial Automation**	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on industrial automation and its applications.

Course Contents:

UNIT I: Automation: Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems.

UNIT II: Material handling: Introduction, material handling systems, principles and design, material transport system: transfer mechanisms automated feed cut of components, performance analysis, uses of various types of handling systems including AGV and its various guiding technologies.

UNIT III: Storage system: Performance, location strategies, conventional storage methods and equipments, automated storage systems.

UNIT IV: Automated manufacturing systems: Components, classification, overview, group technology and cellular manufacturing, parts classification and coding, product flow analysis, cellular manufacturing, application considerations in G.T.

UNIT V: FMS: Introduction, components, application, benefits, planning and implementation, transfer lines and fundamentals of automated production lines, application, analysis of transfer line without internal storage (numerical problems).

UNIT VI: Inspection Technology: Introduction, contact and non-contact conventional measuring, gauging technique, CMM, surface measurement, machine vision, other optical inspection techniques, non-contact non-optical inspection technologies versus.-

UNIT VII: Manufacturing support system: Process planning and concurrent engineering- process planning, CAPP, CE and design for manufacturing, advanced manufacturing planning, production planning and control system, master production schedule, MRP.

UNIT VIII: Capacity planning, shop floor control, inventory control, MRP-II, J.I.T production systems. lean and agile manufacturing.

Suggested Readings:

1. M.P. Groover, Automation, "Production Systems and Computer Integrated manufacturing", Pearson Education.
2. Vajpayee, "Principles of CIM", PHI.
3. Viswanathan and Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI.
4. R.S. Pressman, "Numerical Control and CAM, John Wiley.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD16	**Computational Techniques for Vibration Analysis and Control**	**3L-0T-2P**	**4**	**None**

Course Outcome:

- Upon completion of the course work, the students will be able to develop a complete FEM solution strategy for vibration and control of mechanical and structural systems.

Course Contents:

Unit I: Introduction: Review of vibration analysis of one, two, multi-degrees of freedom and continuous systems- Formulation of equations of motion: Hamilton's principle, Lagrange's equation. Development of finite element energy functions: Axial and torque elements, beam and plate bending elements, membrane element-three dimensional solids-axisymmetric solid- Development of equations of motion and boundary conditions.

Unit II: Finite element displacement method: Rayleigh-Ritz method-Axial vibration of bars Torsional vibration of shafts- Bending vibration of beams- Vibration of trusses and frames -Inclusion of shear deformation and rotary inertia effects.

Unit III: In-plane and flexural vibration of plates: In-plane vibration of plates: Linear triangular element-Linear rectangular element- Linear quadrilateral element- Area coordinates for triangles- Linear triangle in area coordinates. Flexural vibration plates: rectangular and triangular elements- conforming and non-conforming elements.

Unit IV: Analysis of free and forced vibration: Eigen value and eigen vectors- orthogonality of eigen vector-Jacobi, LR, QR and QL methods reduction of number of degrees of freedom- Calculation of eigen values and eigen vectors for the physical systems: Bisection/inverse iteration and Lanczos's methods-computation using MATLAB Forced response: Modal analysis- representation of damping: structural and viscous dampingsteady state response to harmonic and periodic excitation- transient response- response to random excitation: response of single degree-freedom, direct and modal response of multidegree of freedom system-simulation using MATLAB.

Unit V: Control of flexible structures: Control systems- stability theory-stability of multi-degrees of freedom systems-analysis of second order system-state space form representation-transfer function analysis-control law design for state space system-linear quadratic regulator-modal control for second order systems-dynamic observer-MATLAB commands for control calculations.

Suggested Readings:

1. M. Petyt, "Introduction to finite element vibration analysis", Cambridge University Press
2. S.S.Rao, "The finite element method in engineering", Pergamon Press.
3. J.N.Reddy, "An introduction to finite element method", McGraw Hill.
4. W.T.Thomson and M.D.Dahleh, "Theory of vibration with applications", Prentice Hall.
5. S.S.Rao, "Mechanical vibration", Prentice Hall.
6. S.G. Kelly, "Theory and problems of mechanical vibrations", McGraw Hill.
7. R.C. Dorf and R.H. Bishop, "Modern control system", Pearson Prentice Hall.
8. K.Ogata, "Modern control engineering", Prentice Hall.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD17	Micro Electro-Mechanical Systems	3L-0T-2P	4	None

Course Outcome:

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

- Become familiar with micro fabrication techniques
- Assess whether using a MEMS based solution is the relevant and best approach
- Select the most suitable manufacturing process and strategies for micro fabrication

Course Contents:

UNIT-I Foundation in Microsystems

Review of microelectronics manufacture and introduction to MEMS- Overview of Microsystems technology, Laws of scaling- The multi disciplinary nature of MEMS- Survey of materials central to micro engineering- Applications of MEMS in various industries

Unit-II Micro Manufacturing Techniques

Photolithography- Film deposition, Etching Processes-Bulk micro machining, silicon surface micro machining-LIGA process-Rapid micro product development.

Unit-III Micro Sensors and Micro Actuators

Energy conversion and force generation-Electromagnetic Actuators, Reluctance motors, piezoelectric actuators, bi-metal-actuator Friction and wear -Transducer principles, Signal detection and signal processing-Mechanical and physical sensors-Acceleration sensor, pressure sensor, Sensor arrays.

Unit-IV Introduction to Micro/Nano Flu ids

Fundamentals of micro fluidics- Micro pump – introduction – Types - Mechanical Micro pump – Non mechanical micro pumps, Actuating Principles, Design rules for micro pump – modeling and simulation, Verification and testing -Applications

Unit-V Microsystem Design and Packaging

Design considerations-Mechanical Design, Process design, Realization of MEMS components using Intellisuite. Micro system packaging-Packing Technologies-Assembly of Microsystems- Reliability in MEMS

Suggested Readings:

1. Maluf, Nadim, "An introduction to Micro Electro-mechanical Systems Engineering", AR Tech house, Boston.
2. Mohamed Gad – el –Hak, "MEMS Handbook" CRC Press.
3. Sabriesolomon"Sensors Handbook", McGraw Hill.
4. Marc F madou" Fundamentals of micro fabrication" CRC Press.
5. Francis E.H Tay and W. O. Choong, "Micro fluidics and bio MEMS application", Springer US.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD18	MEMS and NEMS	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on MEMS and NEMS and its applications.

Course Contents:

Micro and nano mechanics:

principles, methods and strain analysis, an introduction to microsensors and MEMS, Evolution of Microsensors& MEMS, Microsensors& MEMS applications, Microelectronic technologies for MEMS, Micromachining Technology – Surface and Bulk Micromachining, MicromachinedMicrosensors, Mechanical, Inertial, Biological, Chemical,Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Conclusions & Future Trends.

Nanoelectromechanical systems (NEMS)

a journey from MEMS to NEMS, MEMS vs. NEMS, MEMS based nanotechnology – fabrication, film formation and micromachining, NEMS physics – manifestation of charge discreteness, quantum electrodynamical (QED) forces, quantum entanglement and teleportation, quantum interference, quantum resonant tunneling and quantum transport, Wave phenomena in periodic and aperiodic media – electronic and photonic band gap crystals and their applications, NEMS architecture, Surface Plasmon effects and NEMS fabrication for nanophotonics and nanoelectronics, Surface Plasmon detection – NSOM/SNOM

Suggested Readings:

1. **Busch-Vishniac**, Ilene J., "Electromechanical Sensors and Actuators", Springer, 2008.
2. V, G. W. Neudeck and R. F. Pierret, "Introduction to Microelectronics Fabrication", Addison – Wesley.
3. H. J. De Loss Santos, "Introduction to Microelectromechanical Microwave Systems", Norwood, MA: Artech,
4. S. D. Senturia, ,Kluwer, "Microsystems Design", Academic Publishers.
5. H. J. Delos Santos, "Principles and Applications of Nano-MEMS Physics", Springer.
6. Francis E. H, "Materials and Process Integration for MEMS Microsystems", Springer.
7. D. K. Roy, "Quantum Mechanical Tunneling and its Application", World Scientific.
8. H. S. Nalwa, "Encyclopedia of Nanoscience and Technology", American scientific Publishers.
9. P. J. F. Harris, "Carbon Nanotubes and Related Structures", , Cambridge University Press
10. M Sharon and M. Sharon, "Carbon Nanoforms and Applications", McGraw Hill.
11. S. M. Sze, "VLSI Technology", Mc-Graw Hill, NY.
12. S. Datta, "Addison Quantum Phenomena", Wesley.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD19	**Design Of Hydraulic and Pneumatic Systems**	**3L-0T-2P**	**4**	**None**

Course Outcome:

Upon completion of this course the student shall be able to:

- Have fundamental of fluid power control.
- Design special circuits for low cost automation.

Course Contents:

UNIT I Hydraulic Systems and Actuators

Basic principles-Hydraulic Principles. Hydraulic Power Generators - Selection and specification of pumps, pump characteristics. Hydraulic Actuators – Linear, Rotary - Selection –Characteristics.

UNIT II Control and Regulation Elements

Hydraulic Valves: Pressure, Flow, Direction Controls- Proportional Control valve. Fluid power symbols.

UNIT III Design of Hydraulic Circuits

Hydraulic circuits:- Reciprocating, Quick return , Sequencing, synchronizing and other industrial circuits like press circuits - hydraulic milling machine - grinding, planning, copying, forklift, earth mover circuits - design and selection of components - safety and emergency mandrels. Design of Hydraulic circuits – Selection and sizing of components-calculation of frictional head loss-equivalent length for various components- actuator load calculation-pump sizing.

UNIT IV Pneumatic Systems and Circuits

Pneumatic system fundamentals: FRL, actuators and valves. Logic Circuits - Position – Pressure Sensing, switching, electro-pneumatic. Design of Pneumatic circuits using–Karnaugh maps. Cascade-Step counter.

UNIT V Installation, Maintenance and Special Circuits

Pneumatic equipments - selection of components - design calculations -application - fault finding –hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation -Robotic circuits.

Suggested Readings:

1. S. R. Majumdar, “Oil hydraulics and Pneumatics”, Tata McGraw Hill.
2. W. Bolton “Pneumatic and hydraulic systems”, Butterworth Heinemann.
3. Anthony Esposite, “Fluid Power with Applications”, Pearson Education.
4. J. Michael, Pinches and John G Ashby, “Power Hydraulics”, Prentice Hall.
5. Andrew Parr, “Hydraulics and Pneumatics”, Jaico.
6. Dudleyt A Pease and John J Pippenger, “Basic Fluid Power” , Prentice Hall.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD20	Machine Tool Control and Condition Monitoring	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart the knowledge in the area of machine tool control and condition monitoring in a mechatronics perspective.

Course Contents:

UNIT I OVERVIEW OF AUTOMATIC CONTROL IN MACHINE TOOLS

Open loop and closed loop system in machine tools- process model formulation-transfer function control actions-block diagram representation of mechanical pneumatic and electrical systems. Process computer - peripherals-Data logger-Direct digital control-Supervisory computer control.

UNIT II DRIVE SYSTEMS AND FEED BACK DEVICES IN MACHINE TOOLS

Hydraulic and Pneumatic drives, Electrical drives – A.C. Motor, D.C. Motor, Servo motor and Stepper motor. Feedback devices - Syncro, resolver, diffraction gratings, potentiometer, Inductosyn and encoders-application in machine tools.

UNIT III ADAPTIVE CONTROL AND PLC

Adaptive control-types – ACC, ACO, Real time parameter estimation, Applications- adaptive control for turning, milling, grinding and EDM. Programmable logic controller-Functions-Applications in machine tools.

UNIT IV VIBRATION, ACOUSTIC EMISSION / SOUND

Primary & Secondary signals, Online and Off-line monitoring. Fundamentals of Vibration, Sound, Acoustic Emission. Machine Tool Condition Monitoring through Vibration, Sound, Acoustic Emission, Case Studies

UNIT V CONDITION MONITORING, THROUGH OTHER TECHNIQUES

Visual & temperature monitoring, Leakage monitoring, Lubricant monitoring, condition monitoring of Lube and Hydraulic systems, Thickness monitoring, Image processing techniques in condition monitoring.

Suggested Readings:

1. MikellP.Groover, “Automation Production system and Computer Integrated Manufacturing”, Prentice Hall of India Pvt. Ltd.
2. Sushil Kumar Srivstava, “Industrial Maintenance Management”, S.Chand& Company Ltd
3. Manfred Weck, “Hand Book of Machine Tools”, John Wiley & Sons.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD21	Robust Control	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- Know the importance of digital control systems
- Solve problems using z-transform, inverse z- transform techniques.

Course Contents:

UNIT I INTRODUCTION: Norms of vectors and Matrices – Norms of Systems – Calculation of operator Norms – vector Random spaces- Specification for feedback systems – Co-prime factorization and Inner functions – structured and unstructured uncertainty- robustness

UNIT II H2 OPTIMAL CONTROL: Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal estimation-KalmanBucy Filter – LQG Controller

UNIT III H-INFINITY OPTIMAL CONTROL-RICCATI APPROACH: Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information –Hinfinity estimation

UNIT IV H-INFINITY OPTIMAL CONTROL- LMI APPROACH: Formulation – Characterization of H-infinity sub-optimal controllers by means of LMI Approach – Properties of H-infinity sub-optimal controllers – H-infinity synthesis with poleplacement constraints

UNIT V SYNTHESIS OF ROBUST CONTROLLERS & CASE STUDIES: Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration- Control of Inverted Pendulum- Control of CSTR – Control of Aircraft – Robust Control of Second-order Plant Robust Control of Distillation Column.

Suggested Readings:

1. U. Mackenroth “Robust Control Systems: Theory and Case Studies”, Springer International
2. J. B. Burl, “ Linear optimal control H2 and H-infinity methods”, Addison W Wesley.
3. D. Xue, Y.Q. Chen, D. P. Atherton, "Linear Feedback Control Analysis and Design 26 with MATLAB, Advances In Design and Control”, Society for Industrial and Applied Mathematics.
4. I. R. Petersen, V.A. Ugrinovskii and A. V. Savkin, “Robust Control Design using H- infinity Methods”, Springer.
5. M. J. Grimble, “Robust Industrial Control Systems: Optimal Design Approach for Polynomial Systems”, John Wiley and Sons Ltd., Public

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD22	Instrumentation & Sensor Technology	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- Know about measurement and characteristics.
- Know about different type of transducers and its applications.
- Understand Mathematical analysis of different faults diagnosis systems.

Course Contents:

COURSE CONTENTS

UNIT I: Measurement and Characteristics: Elements of a Measurement System; Classification of Instruments; Static Performance Parameters; Loading and Impedance Matching; Errors and Uncertainties in Measurement; Process and Standards of Calibration; Dynamic Characteristics- Transfer Function Representation of a Measurement System, Impulse and Step Responses of First and Second Order Systems, Frequency Response of First and Second Order Systems.

UNIT II: Mechanical Transducers: Temperature- Bimetallic Element and Fluid Expansion type Thermometers; Pressure- Manometers and Bourdon Gauges; Force- Balances, Helical Spiral Springs, Load Cells and Elastic Force Devices; Torque- Torsion Bars and Flat Spiral Springs; Liquid Level- Float Systems and Level to Pressure Converters; Flow- Pitot Static Tubes and Turbine type Flow Meters.

UNIT III: Electrical Transducers: Resistance Thermometers; Interfacing Resistive Transducers to Electronic Circuits; Thermistors- Measurement of Temperature and Thermal Conductivity, Temperature Control; Resistance Strain Gauges- Gauge Factor, Bonded and Unbonded Strain Gauges; Self Generating and Non Self Generating Inductive Transducers; Linear Variable Differential Transformers; Capacitive Transducers - Potentiometric Transducers; Thermoelectric Transducers and Sources of Errors in Thermocouples; Piezoelectric and Magnetostrictive Transducers; Photoelectric Transducers- Photoemissive, Photoconductive and Photovoltaic types; Electromechanical Transducers- Tachometers, Digital Transducers-Electromagnetic Frequency Domain and Optoelectrical Frequency Domain Transducers, Vibrating String Transducers.

UNIT IV: Basic Signal Conditioning Elements: Amplifiers- Non Electrical and Electrical types; Op Amps- Inverting, Non Inverting, Summing, Differential, and Charge Amplifiers; Differentiating and Integrating Elements; Filters; A to D and D to A Converters- Potentiometric, Dual Slope and Counting types; Data Transmission Elements- Electrical, Pneumatic, Position and Radio Frequency Transmission types; Compensation Elements for First and Second Order Systems - Basic Indicating, Recording, and Display Elements.

UNIT V: Feedback in Instruments- Principles of Feedback and Advantages & Disadvantages of Feedback; Digital Voltmeters-Ramp and Dual Slope types; Servo type Potentiometric and Magnetic Tape Recorders; Digital Recorders

of Memory type; Data Displays-Analog and Digital types. Advanced Measuring Techniques: Temperature- Total and Selective Radiation type Pyrometers; Pressure-McLeod Gauge, Ionization Gauge; Flow- Ultrasonic and Electromagnetic Flow Meters, Hot Wire Anemometer.

UNIT VI: Proximity Sensors- Reed Sensors, Inductive proximity sensor, Capacitive proximity sensor, Optical sensor with through beam, Retro Reflective, Diffuse sensors, Analog inductive, Analog capacitive, Analog optical, Ultrasonic sensors.

Suggested Readings:

1. Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson Education Publications
2. Electronic Instrumentation, H.S. Kalsi-TMH Publications

REFERENCE BOOKS:

1. Albert D Helfrick and William D Cooper; "Modern Electronic Instrumentation and Measurement Techniques", PHI.
2. BC Nakra, and Chaudhry; "Instrumentation, Measurement and Analysis" Tata McGraw-Hill.
3. DVS Murthy, "Transducers and Instrumentation", PHI.
4. CS Rangan, GR Sarma, and VSV Mani, "Instrumentation Devices and Systems", Tata McGraw-Hill.
5. Doeblin and Ernest; "Measurement Systems Application and Design", Tata McGraw-Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD23	Introduction To Optimization Methods	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- Know about optimization techniques and programming.
- Know about multi-objective programming.
- Know about implementation in real life problems.

Course Contents:

UNIT I: Introduction: An overview of optimization problems, some simple illustrative examples

UNIT II: Linear Programming: Introduction, graphical method, simplex method, method of artificial variabl alternate optima, redundancy in linear programming, degeneracy and cycling, the simplex tableau in condensed form.

UNIT III: Nonlinear programming: Introduction, Lagrange multipliers, Karaush-Kuhn-Tucker (KKT) optimal conditions, convexity, sufficiency of the KKT conditions, Duality and convexity.

UNIT IV: Goal Programming: Concept of Goal Programming, Model Formulation, Graphical solution method.

UNIT V: Approximation Techniques: Introduction, line search methods, gradient based methods, approximati under constraints.

UNIT VI: Search Techniques: Direct search and gradient methods, Unimodal functions, Fibonacci method, Gold Section method, Method of steepest descent, Newton-Raphson method, Conjugate gradient methods.

UNIT VII: Dynamic Programming: Sequential optimization; Representation of multistage decision process; Types multistage decision problems; Concept of sub optimization and the principle of optimality; Recursive equations Forward and backward recursions; Computational procedure in dynamic programming (DP); Discrete versus continuo dynamic programming; Multiple state variables; curse of dimensionality in DP

UNIT VIII: Multiobjective Programming: Efficient solutions, Domination cones.

Suggested Readings:

1. Mokhtar S. Bazaaraa, Hanif D. Shirali and M.C.Shetty, "Nonlinear Programming Theory and Algorithms John Wiley & Sons.
2. Pablo Pedregal, "Introduction to optimization", Springer.
3. Suresh Chandera, Jaydeva, and Aparna Mehta, "Numerical optimization with applications", Narosa.
4. Edvin K.P. Chong, and Stanislaw H. Zak, "An Introduction to optimization", John Wiley
5. Mohan C. Joshi and Kannan M Moudgalya, "Optimization theory and practice", Publisher,Narosa
6. D. G. Luenberger, "Linear and Nonlinear Programming", Addison Wesley
7. R. E. Steuer, Multi Criteria Optimization, Theory, "Computation and Application", John Wiley and Sons.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD24	Signal Processing In Mechatronic Systems	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- Know about different type filter applications in mechatronic.
- Understand the designing of different types of filters for mechatronics.
- Understand DSP processors.

Course Contents:

UNIT I: Discrete- Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals

UNIT II: Discrete systems: Z-Transform, Analysis of LSI systems, Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems.

UNIT III: Frequency selective filters: Ideal filter characteristics, lowpass, highpass, bandpass and bandstop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-pass filters, inverse systems, minimum phase, maximum phase and mixed phase systems.

UNIT IV: Design of FIR and IIR filters: Design of FIR filters using windows, frequency sampling, Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations, Butterworth, Chebyshev Filters.

UNIT V: Introduction to multi-rate signal processing: Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding.

UNIT VI: Introduction to DSP Processors: Introduction to various Texas processors such as TMS320C6713, TMS320C6416, DM6437 Digital Video Development Platform with Camera, DevKit8000 OMAP3530 Evaluation Kit.

UNIT VII: Applications: Application of DSP to Speech and Radar signal processing, A few case studies of DSP applications in multimedia using TI DSP kits.

Suggested Readings:

1. S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, Tata McGraw-Hill
2. A. V. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India.
3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, , Pearson Education.
4. V.K. Ingle and J.G. Proakis, “Digital signal processing with MATLAB”, Cengage.
5. T. Bose, “Digital Signal and Image Processing”, John Wiley and Sons, Inc.
6. L. R. Rabiner and B. Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall.
7. A. Antoniou, “Digital Filters: Analysis, Design and Applications”, Tata McGraw-Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD25	Fault Detection And Diagnosis	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

2. Upon completion of this course, the students can able to
3. Know about different type of faults occurred in a system.
4. Understand Mathematical analysis of different faults.
5. Understand Structured and directional concepts techniques for FDI design.

Course Contents:

UNIT I: Introduction to Fault Detection and Diagnosis: Scope of FDD:- Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.

UNIT II: Analytical Redundancy Concepts: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.

UNIT III: Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

UNIT IV: Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.

UNIT V: Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

Suggested Readings:

1. Janos J. Gertler, Fault Detection and Diagnosis in Engineering systems, Macel Dekker.
1. Sachin. C. Patwardhan, Fault Detection and Diagnosis in Industrial Process – Lecture Notes, IIT Bombay,
2. Rami S. Mangoubi, Robust Estimation and Failure detection. Springer-Verlag-London.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD26	Drives And Controls For Automation	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge in the area of hydraulic, pneumatic electric actuators and their control.

Course Contents:

UNIT I FLUID POWER SYSTEM GENERATION AND ACTUATORS: Need for automation, Classification of drives-hydraulic, pneumatic and electric –comparison – ISO symbols for their elements, Selection Criteria. Generating Elements-- Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification - Drive characteristics – Utilizing Elements-- Linear actuator – Types, mounting details, cushioning – power packs – accumulators

UNIT II CONTROL AND REGULATION ELEMENTS: Control and regulation Elements—Direction, flow and pressure control valves--Methods of actuation, types, sizing of ports. spool valves-operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance

UNIT III CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS: Typical Design methods – sequencing circuits design - combinational logic circuit design—cascade method - -Karnaugh map method-- Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits.

UNIT IV ELECTRICAL ACTUATORS: D.C Motor--Working principle ,classification, characteristics, Merits and Demerits, Applications- AC Motor-- Working principle, Types, Speed torque characteristics, Merits and demerits, Applications Stepper motor- principle ,classification, construction. Piezo electric actuators – Linear actuators - Hybrid actuators – Applications

UNIT V ELECTRICAL DRIVE CIRCUITS: DC Motors - Speed ,direction and position control using H-bridge under PWM mode**.** Control of AC motor drives- Need for V/ F drives – Energy saving AC drives.– Stepper Motor – Drive circuits for speed and position control, BLDC motor – Controller – Switched reluctance motor.

Suggested Readings:

1. Antony Esposito, “Fluid Power Systems and control”, Prentice-Hall.
2. Peter Rohner, “Fluid Power logic circuit design”, The Macmillan Press Ltd.
3. E.C.Fitch and J.B.Suryaatmadyn., “Introduction to fluid logic”, McGraw Hill.
4. W.Bolton, Mechatronics, “Electronic control systems in Mechanical and Electrical engineering”, Pearson Education.
5. GopalK.Dubey, “Fundamentals of electrical drives”, Narosa Publications.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD27	Energy Auditing and Management	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on energy auditing and its applications.
- Financial management and its application in renewable system.

Course Contents:

UNIT I Energy Scenario: Energy needs of growing economy, Long term energy scenario, Energy pricing, Ener sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy sonservation and importance, Energy strategy for the future, Energy conservation Act-2001 and its features.

UNIT II Energy Management and Audit: Definition, Energy audit- need, Types of energy audit, Energy manageme (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitutio Energy audit instruments

UNIT III Material and Energy Balance: Facility as an energy system, Methods for preparing process flow, Mater and energy balance diagrams.

UNIT IV Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques- Simp payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitiv analysis, Financing options, Energy performance contracts and role of ESCOs.

UNIT V Electrical System: Electricity tariff, Load management and maximum demand control, Power fact improvement, Distribution and transformer losses. Losses in induction motors, Motor efficiency, Factors affecti motor performance, Rewinding and motor replacement issues, energy efficient motors. Light source, Choice of lightir Luminance requirements, and Energy conservation avenues

Suggested Readings:

1. Abbi, Y.P. and Jain, S, Handbook on Energy Audit and Environment Management, Teri Press.
2. P.Diwan and P.Dwivedi, “Energy Conservation”, Pentagon Press.
3. A.Thumann, W.J.Younger, T.Niehus, “Handbook of Energy Audits”, CRC Press.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD28	Evolutionary Computations	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on evolutionary computations and its applications.

Course Contents:

Introduction: A brief history of evolutionary computation, Elements of Genetic Algorithms, A simple gene algorithm, Applications of genetic algorithms.

Genetic Algorithms in Scientific Models: Evolving computer programs, data analysis & prediction, evolving neu networks, Modeling interaction between learning & evolution, modeling sexual selection, measuring evolutiona activity.

Theoretical Foundation of Genetic Algorithm: Schemas & Two-Armed and k-armed problem, royal roads, exa mathematical models of simple genetic algorithms, Statistical- Mechanics Approaches.

Computer Implementation of Genetic Algorithm: Data structures, Reproduction, crossover & mutation, mappi objective functions to fitness form, fitness scaling, coding a multiparameter, mapped, fixed point coding, discretizati and constraints.

Some Applications of Genetic Algorithms: The risk of genetic algorithms, De Jong's & function optimizatic Improvement in basic techniques, current application of genetic algorithms

Advanced Operators and Techniques in Genetic Search: Dominance, duplicity, & abeyance, inversion & oth reordering operators. Other micro operators, Niche & speciation, multiobjective optimization, knowledge bas techniques, genetic algorithms & parallel processors.

Suggested Readings:

1. David E. Goldberg, "Genetic algorithms in search, optimization & Machine Learning", Pearson Education.
2. Melanle Mitchell, "An introduction to genetic algorithms", Prentice Hall India.
3. Michael D. Vose, "The simple genetic algorithm foundations and theory", Prentice Hall India.
4. Masatoshi Sakawa, "Genetic Algorithms & Fuzzy Multiobjective Optimization", Kluwer Academic Publishe
5. D. Quagliarella, J Periaux, C Poloni& G Winter, "Genetic Algorithms in Engineering & Computer science", John Wiley & Sons.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD29	Fundamentals of Electrical	3L-0T-2P	4	None

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

	Machines And Drives			

Course Outcome:

Upon completion of this course the student shall be able to:

- Know about electrical machine construction and performance characteristics.
- Know about different drives systems and its application.

Course Contents:

UNIT I: Introduction to Transformer: Working Principle, Construction, Operation and Equivalent circuit.

UNIT II: Basic Concept of Rotating Machines: Parts of rotating electrical machines, Torque production and Ener conversion.

UNIT III: D. C. Motors: EMF equation, Types of DC Motors, Torque speed characteristics, types of starters and spe control, losses and efficiency, application of DC motors.

UNIT IV: Three-Phase Induction Motors: Construction, Principle of working, Rotating magnetic field productic Slip, Equivalent circuit, Torque-slip characteristics, Speed control and method of starting and applications.

UNIT V: Special Motors: Single phase motors, Stepper motor, Servomotors, Synchronous motor

UNIT VI: Industrial Applications: Case studies of motor drive system for steel mills, paper mills and machine to application.

Suggested Readings:

1) AshfaqHussian, “Electrical Machines”, Dhanpat Rai & Company.
2) P.S. Bhimbra, “Electrical Machinery”, Khanna Publishers.
3) S. J. Chapman, “Electrical Machinery”, McGraw Hill.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD30	**Power Quality And**	**3L-0T-2P**	**4**	**None**

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

	Harmonics			

Course Outcome:

Upon completion of this course the student shall be able to:

3. To understand about power quality phenomenon and its effects on the system.
6. Know about different measures and standards related to PQ.
7. Understand the designing concepts of mitigation systems for PQ.
8. Understand about grounding and its applications.

Course Contents:

UNIT I: Introduction: Introduction to power quality, voltage quality. Overview of power quality, Power quality phenomena and classification of power quality issues.

UNIT II: Power quality measures and standards-THDTIF-DIN-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, EMC standards and recommended practices.

UNIT III: Harmonic Device Modeling: Harmonics background, basic concepts, Fourier analysis. Harmonics-individual andtotal harmonic distortion-RMS value of a harmonic waveform-triplex harmonic-important harmonic introducingdevices-Transformer, Three phase power converters-arcing devices-saturabledevices.Harmonic distortion due tofluorescentlamps.Effect of power system harmonics on power system equipment and loads.

UNIT IV: Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and impact on drives.

UNIT V: Harmonic Mitigation: Harmonic resonance, Impedance Scan Analysis- Passive filtering. Introduction to active power filtering. Control methods for single phase APFC.

UNIT VI: Grounding: Grounding and wiring –introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-soklutions to grounding and wiring problems.

Suggested Readings:

1. Ambrish Chandra, Bhim Singh, and Kamal Al-Haddad, “Power Quality: Problems and Mitigation Techniques”, Wiley.
2. G. T. Heydt, “Electric Power Quality”, CRC Press
3. J. Arrillaga, B. C. Smith, N. R. Watson & A. R. Wood, Power System Harmonic Analysis,
4. Understanding Power Quality Problems, Math H. Bollen.
5. Jos Arrillaga, Neville R. Watson, S. Chen, Power System Quality Assessment, Wiley.
6. Mark Lamendola, IEEE standard on electrical grounding.

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD31	Digital Control Systems	3L-0T-2P	4	None

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course Outcome:

Upon completion of this course the student shall be able to:

- Know the importance of digital control systems
- Solve problems using z-transform, inverse z- transform techniques.
- Know the advantage of state variable technique, controllability, observability for effective design of controller using digital technique.

Course Contents:

UNIT I Introduction

Sampling and holding – Sample and hold device D/A, A/D conversion – Z transform – Inverse Z transform – properties – Pulse transfer function and response between sampling intervals – Reconstruction.

UNIT II Variable Technique

State equations of discrete data systems – State transition equations – Relationship between state equation and transfer functions - Characteristic equations – Eigen value –eigen vector – Diagonalization of Matrix – Jordan canonical form – Methods of computing state transition matrix – State diagram – Decomposition of discrete data transfer function.

UNIT III Controllability, Observability and Stability

Controllability and observability of linier time invariant discrete data systems – Relationships between controllability, observability and transfer function-Stability of linier discrete control system – Stability tests – Bilinear transformation method – Jury's stability test.

UNIT IV Design of Digital Control Systems

Correlation between time response and root locations in S plane and Z plane – Direct design in Z and W plane – State space design – Design via pole placement, digital PID controller design.

UNIT V Microprocessor Based Control

Selection of processors – Mechanization of control algorithms – Merits and demerits – Applications of temperature control – Control of electric drives.

Suggested Readings:

1. K. Ogata, " Discrete Time Control Systems", Pearson Education Asia.
2. B.C. Kuo, "Digital Control Systems", Oxford University Press.
3. M. Gopal, "Digital Control Engineering", Willey Eastern Ltd.
4. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD32	Precision Engineering	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- The concept of accuracy identification and measuring systems.
- Know about Datum systems.
- Understand Mathematical analysis of different faults.
- Understand about tolerance charting techniques and nano-technologies.

Course Contents:

UNIT I:Concepts Of Accuracy: Introduction – Concept of Accuracy of Machine Tools – Spindle ad Displacement Accuracies –Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags.

Geometric Dimensioning And Tolerancing: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums–Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerancing.

UNIT II:Datum Systems: Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT III: Tolerance Analysis: Process Capability , Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances.

Tolerance Charting Techniques-Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples. Design features to facilitate machining; Datum Features – functional and manufacturing. Components design – Machining considerations, Redesign for manufactured, Examples

UNIT IV: Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

.**UNIT V:Fundementals of Nanotechnology**: System of nanometer accuracies – Mechanism of metal Processing – Nano physical processing of atomic bit units. Nanotechnology and Electrochemical atomic bit processing.

Measuring Systems Processing:In processing or insitumeasurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.

Suggested Readings:

1. Murthy R. L., “Precision Engineering in Manufacturing”, New Age International (P) limited.
2. James D.Meadows, “Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc.
3. Norio Taniguchi, “Nano Technology”, Oxford University Press.
4. Matousek, “Engineering Design – A systematic Approach”, Blackie & Son Ltd, London.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD33	Reliability Engineering	3L-0T-2P	4	None

Course Outcome:

- On completion of this course, the student shall be able to acquire good knowledge on reliability of products through the failure concepts, failure distributions, Serial & parallel systems and their risk assessment.

Course Contents:

UNIT I Reliability Concept

Reliability function - failure rate - Mean Time Between Failures (MTBF) - Mean Time to Failure (MTTF) - a priori and a posteriori concept - mortality curve - useful life availability - maintainability - system effectiveness.

UNIT II Reliability Data Analysis

Time-to-failure distributions - Exponential, normal, Gamma, Weibull, ranking of data - probability plotting techniques - Hazard plotting.

UNIT III Reliability Prediction Models

Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis - FTA - Limitations.

UNIT IV Reliability Management

Reliability testing - Reliability growth monitoring - Non parametric methods - Reliability and life cycle costs - Reliability allocation - Replacement model.

UNIT V Risk Assessment

Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

Suggested Readings:

1. Modarres, " Reliability and Risk analysis ", Mara Dekker Inc.,
2. John Davidson, “The Reliability of Mechanical system ", Institution of Mechanical Engineers.
3. C.O. Smith, “Introduction to Reliability in Design ", McGraw Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD34	**Real Time Systems And Software Development**	**3L-0T-2P**	**4**	**None**

Course Outcome:

- Understand the concepts of embedded computing
- Analyse the real-time system requirements
- Understand the connectivity technologies

Course Contents:

Unit I Introduction: Real Time Systems - Embedded Systems - Pervasive Computing - Information Access Devices - Smart Cards -Embedded Controllers - Hardware Fundamentals.

Unit II RTOS : Real Time Operating Systems - Memory Management - Processes, Threads, Interrupts, Events - User Interface.

Unit III REAL TIME UML: Requirements Analysis - Object Identification strategies - Object Behavior - Real-Time Design Patterns

Unit IV SOFTWARE DEVELOPMENT: Concurrency - Exceptions - Tools - Debugging Techniques - Optimization - Case Studies.

Unit V CONNECTIVITY: Wireless Connectivity - Blue Tooth - Other Short Range Protocols - Wireless Application Environment – Service Discovery – Middleware.

Suggested Readings:

1. Philip A.Laplante, “Real time system design and analysis – an engineer's handbook, John Wiley- India.
2. R.J.A. Buhr, D.L.Bailey, "An Introduction to Real-Time Systems ", Prentice-Hall International.
3. B.P.Douglass, " Real-Time UML", Addison-Wesley.
4. D.E. Simon, "An Embedded Software Primer ", Addison-Wesley.
5. J.Schiller, "Mobile Communications ", Addison-Wesley.
6. V.Hansmann, L.Merk, M.S. Nicklous, T.Stober, " Prevasive Computing Handbook ", Springer.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD35	Concepts in Electronics Engineering	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To understand the basics and working principles of electronic components and their applications

Course Contents:

UNIT I ELECTRONIC COMPONENTS AND DEVICES

Resistors, Capacitors, Inductors, Transformers – types and properties,- Junction diodes, Zener diodes, Bipolar transistors, Field Effect transistors, Uni junction Transistors, MOS Devices, LEDs – Characteristics and applications; Thyristor Devices – SCR, DIAC, TRIAC, QUADRAC – operating mechanism, characteristics and applications.

UNIT II ANALOG ELECTRONICS

Rectifiers and Filters; Regulated Power Supply – Switching Power Supplies, Thermal Considerations, Feedback and power amplifiers , Sine wave oscillators,

UNIT III OPERATIONAL AMPLIFIERS AND APPLICATIONS

Operational amplifiers – Principles, Specifications, characteristics and applications. Arithmetic Operations, Integrator, Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Active filters, Linear Rectifiers, Waveform Generators, D/A converters.

UNIT IV DIGITAL ELECTRONICS

Number systems – Logic gates – Boolean algebra – Simplification of Boolean functions using Map method. Tabulation method – Combinational logic circuits: Full adder, Code Converters, Multiplexers, Decoders – Sequential logic circuits: Flip-flops, Counters, Shift registers – A/D Converters.

UNIT V TEST AND MEASURING INSTRUMENTS

Measurement of voltage, current ,frequency and power using Multi meters , oscilloscopes, recorders, data loggers, signal sources, counters, analyzers and printers.

Suggested Readings:

1. Mill Man and Halkias":Electron devices and circuits" McGraw-Hill
2. Jocob Mill Man, "Micro electronics Digital and Analog circuits & Systems", McGraw-Hill.
3. Ray &Chaudary, "Linear Integrated Circuits", New Age.
4. Malvino& Leach, "Digital Principals & application", TMH.
5. Helfrick A.D and Cooper .W. D. "Modern Electronic Instrumentation and Measurements Techniques" Printice Hall.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
MTD36	Machine Vision	3L-0T-2P	4	None

Course Outcome:

Upon completion of this course the student shall be able to:

- To impart knowledge on imaging, machine vision and its applications.

Course Contents:

UNIT I INTRODUCTION

Human vision – Machine vision and Computer vision – Benefits of machine vision – Block diagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation

UNIT II IMAGE ACQUISITION

Scene constraints – Lighting parameters – Lighting sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection – Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog and Digital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications and Selection – Geometrical Image formation models – Camera Calibration

UNIT III IMAGE PROCESSING

Machine Vision Software – Fundamentals of Digital Image – Image Acquisition Modes – Image Processing in Spatial and Frequency Domain – Point Operation, Thresholding, Grayscale Stretching – Neighborhood Operations, Image Smoothing and Sharpening – Edge Detection – Binary Morphology – Color image processing.

UNIT IV IMAGE ANALYSIS

Feature extraction – Region Features, Shape and Size features – Texture Analysis – Template Matching and Classification – 3D Machine Vision Techniques – Decision Making.

UNIT V MACHINE VISION APPLICATIONS

Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile, applications in non-visible spectrum, metrology and gauging,OCR and OCV, vision guided robotics – Field and Service Applications – Agricultural, and Bio medical field, augmented reality, surveillance, bio-metrics.

Suggested Readings:

1. EmanueleTrucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, Prentice Hall.

2. Rafael C.Gonzales, Richard.E.Woods, “Digital Image Processing”, Addison-Wesley

3. Alexander Hornberg, “Handbook of Machine Vision”, Wiley-VCH

4. Eugene Hecht, A.R. Ganesan“Optics”, Pearson Education India.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

COURSE CONTENTS OF OPEN ELECTIVES

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

Course Outcome:

a) 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.
b) This will enhance the students capability to prepare technical documents and correspondence.
c) The course will equip the student with good communications skills for placements, preparing SOPs and CVs.
d) The course will sensitize the students towards research ethics, copyright and plagiarism.

Course Contents:

Course Structure

- 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. Advanced English Grammar: Martin Hewing
2. Technical Communication: Meenakshi Raman &Sangeeta Sharma, Oxford University Press India

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:

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

Course Contents:

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,AK Singh, "Disaster Management in India:Perspectives, issues and strategies" New Royal book Company.

2., Pardeep Sahni Et.Al. " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India.

3. Goel S. L., "Disaster Administration And Management: Text And Case Studies", Deep &Deep Publication Pvt. Ltd.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:
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.

Course Contents:
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:
11. M.Y Khan, P.K. Jain, " Financial Management: Text and Problems", Tata McGraw Hill.
2. Rajiv Srivastava, Anil Mishra, "Financial Management", Oxford University Press, UK.
3. P. Cha ndra, " Financial Management-Theory and Practice", Tata McGraw Hill.
4. James C,VanHorne, John M. Wachowicz, " Fundamentals of Financial Management", Pearson Education.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:
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.

Course Contents:
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
2. T.N. Chhabra, " Human Resource Management", Dhanpat Rai and Co.
3. Saiyadain S. Mirza, " Human Resource Management", Tata Mc-GrawHill.
4. N.K.Chadha, "Human Resource Management-issues, case studies, experiential exercises", Sri Sai Printographers.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:
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.

Course Contents:
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, Inc.
3. Goodpasture, J. C. " Quantitative Methods in Project Management," J Ross Publishing,
4. Meredith, J. R. and Mantel Jr., S. J. " Project Management: A Managerial Approach", John Wiley
5. Clifford Gray, "Project Management: The Managerial Process"" McGraw Hill Higher Education.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:
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.

Course Contents:
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 Practic", Taxmann
4. Hanningan, Brenda, "Company Law", Oxford University Press
5. Sharma, J.P., "An Easy Approach to Corporate Laws", Ane Books Pvt. Ltd.
9. Ramaiya, "A Guide to Companies Act", LexisNexis Buttersworthwadhwa.
6. Kannal, S., & V.S. Sowrirajan, "Company Law Procedure", Taxman's Allied Services (P) Ltd.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:

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

Course Contents:

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,
Introduction, Orientation and UNIX,

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. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO008	Basic of social science	**3L-1T-0P**	**4**	**None**

Course Outcome:

Sociology 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".

Course Contents:

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, Chap 17.
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. (MECHATRONICS)

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

Course Outcome:
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.

Course 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.
2. Hishrich., Peters, "Entrepreneurship: Starting, Developing and Managing a New Enterprise", Irwin Publishing Ltd.
3. 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
6. Lall, Madhurima, and ShikhaSahai, "Entrepreneurship", Excel Books.
7. Charantimath, Poornima, "Entrepreneurship Development and Small Business Enterprises", Pearson Education,

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:
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

Course Contents:

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. RajniBedi, " Social Work: An Introductory Text Book", Regal Publications
2. Sanjay Bhattacharya, " Social Work: An Integrated Approach" Deep and Deep publication
3. NiteshDhawan, " Social work perspective Philosophy and Methods", Bharat Book Centre.
4. P. R. Gautam , " Social Work: Methods Practices And Perspectives", Centrum Press

Passed in the meeting of standing committee on Academic matters held on June 3, 2016

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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. (MECHATRONICS)

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

Course Outcome:
Supply chain management consist 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.

Course Contents:

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

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

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

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

Course Contents:
1. Organtzattonal Systems and Human Behaviour - Developing a basic knowledge of how organizattons and groups furnction 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, practise alternative ways ofapproaching 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 organizationdevelopment, especially those relating to the role of consultant and strategies forchange.
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 lor the process. This provides participants with an opporfunity to consolidate andde,monstrate 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. (MECHATRONICS)

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

Course Outcome:

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

Course 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-economics 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

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

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

Course Outcome:
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.

Course Contents:
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," McGraw Hill.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

Course No.	Title of the Course	Course structure	Credit	Pre-Requisite
EO017	**Biology For Engineers**	**3L-1T-0P**	**4**	**None**

Course Outcome:

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 or any other suitable organism as a study-model for engineering students.
5. Understanding electrical, chemical and magnetic forces, and communication networks in biosystem.

Course Contents:

The Biological system – An Introduction; Biomolecules &self assemblies; Molecular recognition; Bioenergetics; Communication network in biosystem; Mechanics in biology; Storage, preservation and propagation of biological information; Biomaterials in engineering applications; Organisms as factories for biomaterials; Engineering organisms for novel applications

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,
4. Michael Roberts, Michael Jonathan Reiss, Grace Monger, " Advanced Biology", Nelson Thornes.
5. Hermann Remmer, " Ecology: A Textbook", Springer.
6. Colin Ratledge, Bjorn Kristiansen , " Basic Biotechnology", Cambridge University Press.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:

1. To be able to assess the energy resources available worldwide
2. To understand the negative impact of conventional energy resource utilization on ecosystem
3. To learn about various types of pollutions and their control strategies
4. To understand renewable energy resources and their socio-economic impac

Course Contents:

Introduction to Environment, Energy and its impact on society

Universe, Environment and Ecosystem: Origin of earth, atmosphere, Origin of Life, Ecosystem, Biotic and abiotic components, Ecological pyramids, Food chain, Food web, Habitat and Niche, Major ecosystems, Atmosphere, Biodiversity

Pollution: Air Pollution, Water Pollution, Soil Pollution, Noise Pollution

Energy: Different sources of Energy, Renewable sources of energy, Non renewable energy,

Bioenergy, Bioethanol and Biodiesel

Biofertilizers, Biopesticides and Biopolymers

Environmental Ethics and Morals

Suggested Readings:

1. Kishore V N, Editor, Renewable Energy Engineering and Technology, Principles and Practice, The Energy and Resources Institute (TERI), 2009
2. G. N. Tiwari and M. K. Ghosal, " Fundamentals of Renewable Energy Sources", Narosa Publishing House, N.D,
3. Mital K. M, "Biogas Systems: Principles and Applications", New Age International publishers (P) Ltd
4. Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd
5. Yogi Goswami, Frank Kreith, Jan. F .Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis.
6. Rezaiyan. J and N. P. Cheremisinoff, Gasification Technologies, " A Primer for Engineers and Scientists" Taylor and Francis.

SCHEME OF COURSES – M.TECH. (MECHATRONICS)

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

Course Outcome:
Students will be introduced to Public Policy and Administrative governance. They will also learn about Administrative Governance.

Course 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, " *Shrinkingthe State: Globalization and Public administration Reform."* Halifax: Fernwood,
2. Beryl Radin, , " Policy Analysis Reaches Midlife, 2nd edition. 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", University of Chicago Press.
4. Timothy Conlan, Paul Posner, and David Beam (2015), "Pathways of Power: The dynamics of National Policymaking", Washington, DC: Georgetown University press.