Model Curriculum for UG Degree Course in

Mechatronics

2020

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION

Nelson Mandela Marg, Vasant Kunj, New Delhi 110070

www.aicte-india.org

Model Curriculum for UG Degree Course in Mechatronics Engineering

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION

NELSON MANDELA MARG, Vasant Kunj, New Delhi – 110070

www.aicte-india.org

MESSAGE

The quality of technical education depends on many factors but largely on-outcome based socially and industrially relevant curriculum, good quality motivated faculty, teaching learning process, effective industry internship and evaluation of students based on desired outcomes. Therefore, it was imperative that a Model Curriculum be prepared by best experts from academia and industry, keeping in view the latest industry trends and market requirements and be made available to all universities / board of technical education and engineering institutions in the country. AICTE constituted team of experts to prepare the model curriculum of UG Degree Course in Mechatronics Engineering. Similar exercise is done for other UG, Diploma and PG level in engineering, MBA, PGDM, Architecture, etc.

It comprises of basic science and engineering courses, having focus on fundamentals, significant discipline level courses and ample electives both from the disciplines and cross disciplines including emerging areas all within a cumulative structure of 163 credits. Summer Internships have been embedded to make the student understand the industry requirements and have hands on experience. Virtual Labs has been introduced for few experiments. Also, most courses have been mapped to its equivalent SWAYAM/NPTEL Course to offer an alternative for learning that course online from SWAYAM. These features will allow students to develop a problem-solving approach to face the challenges in the future and develop outcome based learning approach.

As a major initiative by AICTE, a three-week mandatory induction program for students has also been designed and has to be given at the beginning of the course. The idea behind this is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

AICTE places on record, special thanks to Prof. Sunil Jha, Prof. S.D. Agashe, Prof. Ashiv Shah and Mr. Vikram Mattoo. We are sure that this Model Curriculum will help to enhance not just the employability skills but will also enable youngsters to become job creators.

We strongly urge the institutions / universities / boards of technical education in India to adopt this Model Curriculum at the earliest. This is a suggestive curriculum and the concerned university / institution / board should build on and exercise flexibility in readjustment of courses within the overall 163 credits.

(Prof. Anil D. Sahasrabudhe)
Chairman
All India Council for Technical Education

PREFACE

Taking cognisance of growing concern about quality of technical education in India, AICTE in its 49th council meeting held on 14.03.2017 approved a package of measures for improving quality of technical education - Revision of Curriculum, Mandatory Internship, and Student Induction Program were amongst the few.

AICTE constituted committee of academia industry experts to prepare model curriculum of UG Course in Mechatronics Engineering. During the development of curriculum, the employability and employment opportModuleies for graduates, future ready workforce who will be skilled enough to handle the rapid growth in the field of Mechatronics were kept in mind.

AICTE has introduced mandatory internship in the new curriculum which will equip the students with practical understanding and training about industry practices in a suitable industry or organization. In the course of development of model curriculum, the committee took feedback of industry experts on the draft curriculum and accordingly modified the draft before finalization. This exercise has ensured that essential emphasis on industry requirements and market trends, employability and problem solving approach is given.

After due deliberations, the scheme and syllabus have been formulated. Salient features of this model curriculum are enumerated as under:

- Reduced number of credits.
- Introduction of Student Induction Program.
- Well defined learning objectives & outcomes for each course.
- Inclusion of courses on socially relevant topics.
- Built-in flexibility to the students in terms of professional elective and open elective courses.
- Mandatory internship to equip the students with practical knowledge and provide them exposure to real time industrial environments.
- Virtual Labs.
- Mapping of Courses to its equivalent NPTEL/SWAYAM Course.
- Course on 'Entrepreneurship and Startups' to encourage entrepreneurial mindset.

I gratefully acknowledge the time and efforts of the members of the working group namely Prof. Sunil Jha of IIT Delhi; Prof. S.D. Agashe of College of Engineering, Pune; Prof. Ashiv Shah of AKG Engineering College and Mr. Vikram Mattoo of Mitsubishi Electric India Pvt. Ltd. We also appreciate the feedback on the draft received from Mr. Manoj Yadav of KUKA Robotics; Mr. Bipin Chandra of EDAG Production Solutions Pvt. Ltd., Mr. Chetan Rajdev of Hydac India, Mr. Brajesh Poddar of North SMC Corporation India, Mr. Sangeet of Adverb Technologies and Dr. O.P. Goel of Bosch India.

Special thanks to Prof. Anil D. Sahasrabudhe, Chairman; Prof. M.P. Poonia, Vice-Chairman; and Prof. Rajive Kumar, Member Secretary, AICTE who all have been instrumental and encouraging throughout the process of development of this model curriculum.

I appreciate the dedication put by the Dr. Neeraj Saxena, Adviser-II; Dr. Pradeep C. Bhaskar, Assistant Director (P&AP); Mr. Dharmesh Kumar Dewangan, Young Professional (P&AP); Mr. Rakesh Kumar Pandit Young Professional (P&AP); and other office staff of AICTE.

(Prof. Dileep N. Malkhede)
Advisor – I
Policy and Academic Planning Bureau
All India Council for Technical Education

Committee for Model Curriculum

S. No.	Member Name	Designation & Organization
1	Prof. Sunil Jha	Professor, Department of Mechanical Engineering, IIT Delhi
2	Prof. S.D. Agashe	Professor, Department of Instrumentation and Control, College of Engineering, Pune
3	Prof. Ashiv Shah	Professor, Centre of Excellence in Industrial Automation & Robotics, AKG Engineering College, Ghaziabad (U.P)
4	Mr. Vikram Mattoo	General Manager, Factory Automation Centre, Mitsubishi Electric India Pvt. Ltd, Haryana

Industrial Team who helped with their valuable feedback on the Draft Model Curriculum

S. No.	Member Name	Designation & Organization
1	Mr. Manoj Yadav	General Manager, KUKA Robotics India, Gurgaon
2	Mr. Bipin Chandra	Director Engineering, EDAG Production Solutions India Private Limited, Gurgaon
3	Mr. Chetan Rajdev	National Manager, Hydac India, Bangalore
4	Mr. Brajesh Poddar	Sr. Manager; North SMC Corporation India, Noida
5	Mr. Karun Jain	Academic Program Manager; North West East India, National Instruments, Bangalore
6	Mr. Sangeet	Founder Director, Addverb Technologies

Table of Contents

GENERAL COURSE STRUCTURE &THEME

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits: In the light of the fact that a typical Model Four-year Under Graduate Degree program in Engineering has about 163 credits, the total number of credits proposed for the four-year UG Program (B.E. / B. Tech) in Mechatronics Engineering is 163.

C. Structure of Mechatronics Engineering program: The structure of Mechatronics Engineering program shall have essentially the following categories of courses with the breakup of credits as given:

S. No.	Category	Breakup of Credits
1.	Humanities & Social Science Courses	12*
2.	Basic Science Courses	21*
3.	Mechatronics Engineering Core Courses	101*
4.	Professional Elective Courses (Branch Specific Electives)	6*
5.	Open Elective Courses (Cross Disciplines Elective)	6*
6.	Project work, Seminar and Internship in Industry or elsewhere	17*
7.	Audit Courses [Environmental Sciences, Indian Constitution]	(non-credit)
	TOTAL	**163***

**Minor variation is allowed.*

D. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
MT	Engineering Core courses / Basic Science Courses / Laboratory Courses / Projects / Internships / Engineering Science Courses
MTPE	Professional Elective Courses
MTOE	Open Elective Courses
AU	Audit Courses

- **Course level coding scheme:** Following terminology is used for subject code:
  - MT - Y0X - Theory subjects
  - MT - Y1X - Labs & Practical
  - MTPE - Y0X - Professional Elective Subjects
  - MTOE - Y0X - Open Elective Subjects
  - AU – Y0X - Audit Subjects

  - MT = Theory & Practical Subject/Projects/Internships/Seminar.
  - MTPE = Professional Elective Subjects.
  - MTOE = Open Elective Subjects
  - AU = Audit Courses.
  - Y = Semester: 1 to 8.
  - X = Theory & Practical Subject Serial Number: 1 to 9.

- **Category-wise Courses**

HUMANITIES & SOCIAL SCIENCES COURSES

(i) Number of Humanities & Social Science Courses: 4
(ii) Credits: 12

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	MT-204	English	2	0	2	II	3
2	MT-306	Effective Technical Communication	3	0	0	III	3
3	HSMC(H-102)	Universal Human Values 2: Understanding Harmony	2	1	0	III	3
4	MT-506	Entrepreneurship and Startups	3	0	0	V	3
Total Credits							**12**

****

BASIC SCIENCE COURSES

(i) Number of Basic Sciences Courses: 5
(ii) Credits: 21

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	MT-101	Physics-I	3	1	3	I	5.5
2	MT-102	Mathematics-I	3	1	0	I	4
3	MT-201	Chemistry-I	3	1	3	II	5.5
4	MT-202	Mathematics-II	3	1	0	II	4
5	MT-304	Physics-II	2	0	0	III	2
Total Credits							**21**

****

MECHATRONICS ENGINEERING CORE COURSES

(i) Number of Mechatronics Engineering Core Courses: 44
(ii) Credits: 101

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	MT-103	Basic Electrical Engineering	3	1	2	I	5
2	MT-104	Engineering Graphics & Design	1	0	4	I	3
3	MT-203	Programming for Problem Solving	3	0	4	II	5
4	MT-211	Workshop/Manufacturing Practices	1	0	4	II	3
5	MT-301	Basic Concepts of Mechatronics	3	0	0	III	3
6	MT-302	Strength of Materials	2	1	0	III	3
7	MT-303	Electrical Machines	3	0	0	III	3
8	MT-305	Embedded Systems	3	0	0	III	3
9	MT-311	Basic Mechatronics Lab	0	0	2	III	1
10	MT-312	Strength of Materials Lab	0	0	2	III	1
11	MT-313	Electrical Machines Lab	0	0	2	III	1
12	MT-314	Embedded Systems Lab	0	0	2	III	1
13	MT-401	Fluid Mechanics	3	0	0	IV	3
14	MT-402	Analog and Digital Electronics	3	0	0	IV	3
15	MT-403	Computer Organization	3	0	0	IV	3
16	MT-404	Signals & Systems	3	0	0	IV	3
17	MT-405	Industrial Automation	3	0	0	IV	3
18	MT-411	Fluid Mechanics Lab	0	0	4	IV	2
19	MT-412	Analog and Digital Electronics Lab	0	0	2	IV	1
20	MT-413	Industrial Automation Lab	0	0	4	IV	2
21	MT-414	Signals & Systems Lab	0	0	2	IV	1
22	MT-501	Digital Signal Processing	2	1	0	V	3
23	MT-502	Sensors & Instrumentation	2	1	0	V	3
24	MT-503	Control System Engineering	3	0	0	V	3
25	MT-504	Industrial Management	2	0	0	V	2
26	MT-505	Kinematics and Theory of Machines	3	0	0	V	3

27	MT-511	Digital Signal Processing Lab	0	0	2	V	1
28	MT-512	Sensors & Instrumentation Lab	0	0	2	V	1
29	MT-513	Control System Engineering Lab	0	0	2	V	1
30	MT-514	Kinematics and Theory of Machines Lab	0	0	2	V	1
31	MT-601	Design of Machine Elements	3	0	0	VI	3
32	MT-602	Computer Network & Cyber Security	3	0	0	VI	3
33	MT-603	Microprocessor and Microcontroller	3	0	0	VI	3
34	MT-604	Manufacturing Technologies	3	0	0	VI	3
35	MT-611	Computer Aided Design Lab	0	0	4	VI	2
36	MT-612	Computer Network & Cyber Security Lab	0	0	2	VI	1
37	MT-613	Microprocessor & Microcontroller Lab	0	0	4	VI	2
38	MT-614	Manufacturing Technologies Lab	0	0	2	VI	1
39	MT-701	Robotics	3	0	0	VII	3
40	MT-702	Mechatronics System	2	1	0	VII	3
41	MT-703	Computer Aided Manufacturing	3	0	0	VII	3
42	MT-711	Robotics Lab	0	0	4	VII	2
43	MT-712	Computer Aided Manufacturing Lab	0	0	2	VII	1
Total Credits							**101**

****

PROFESSIONAL ELECTIVE COURSES [MTPE]

(i) Number of Professional Elective Courses: 2
(ii) Credits: 6

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	MTPE-60X	Professional Elective I	3	0	0	VI	3
2	MTPE-70X	Professional Elective II	3	0	0	VII	3
Total Credits							**6**

For detailed syllabus of Professional Elective Course, Refer Appendix I.

****

OPEN ELECTIVE COURSES [MTOE]

(i) Number of Open Elective Courses: 2
(ii) Credits: 6

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	MTOE-80X	Open Elective I	3	0	0	VIII	3
2	MTOE-80X	Open Elective II	3	0	0	VIII	3
Total Credits							**6**

For detailed syllabus of Open Elective Course, Refer Appendix II.

****

PROJECT WORK, SEMINAR, INDUSTRIAL VISIT AND INTERNSHIP

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	MT-315	Mini Project or Internship	-	-	-	III	1
2	MT-415	Industrial Visit	-	-	-	IV	1
3	MT-515	Mini Project or Internship	-	-	-	V	1
4	MT-615	Seminar	-	-	-	VI	1
5	MT-713	Project Work I	0	0	4	VII	2
6	MT-714	Mini Project or Internship	-	-	-	VII	1
7	MT-811	Project Work II	0	0	20	VIII	10
Total Credits							**17**

****

AUDIT COURSES [AU]

Note: These are mandatory non-credit courses.

S. No.	Course Code	Course Title	L	T	P	Semester	Credits
1	AU-102	Sports and Yoga	2	0	0	II	0
2	AU-401	Environmental Science	2	0	0	IV	0
3	AU-501	Indian Constitution	2	0	0	V	0
Total Credits							**0**

****

INDUCTION PROGRAM

The Essence and Details of Induction program can also be understood from the 'Detailed Guide on Student Induction program', as available on AICTE Portal, (Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20Induction%20program.pdf).

For more, Refer **Appendix III.**

Induction program (mandatory)	**Three-week duration**
Induction program for students to be offered right at the start of the first year.	● Physical activity ● Creative Arts ● Universal Human Values ● Literary ● Proficiency Modules ● Lectures by Eminent People ● Visits to local Areas ● Familiarization to Dept./Branch & Innovations

E. Mandatory Visits/ Workshop/Expert Lectures:

a. It is mandatory to arrange one industrial visit every semester.
b. It is mandatory to conduct a One-week workshop during the winter break after fifth semester on professional/ industry/ entrepreneurial orientation.
c. It is mandatory to organize at least one expert lecture per semester for each branch by inviting resource persons from domain specific industry.

F. Evaluation Scheme (Suggestive only):

a. **For Theory & Practical Courses:** The weightage of Continuous Assessment (C.A.) and End Semester Assessment (E.S.A.) is mentioned for every subject. If not mentioned anywhere, then Continuous Assessment may be given 40% weightage and End Semester may be given 60% weightage. The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

b. **For Internship / Projects / Seminar etc.:** Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Note: The internal assessment is based on the student's performance in mid semester tests (two best out of three), quizzes, assignments, class performance, attendance, viva-voce in practical, lab record etc.

G. Mapping of Marks to Grades

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	Assigned Grade
91-100	AA/A+
81-90	AB/A
71-80	BB/B+
61-70	BC/B
51-60	CC/C+
46-50	CD/C
40-45	DD/D
<40	FF/F (Fail due to less marks)
-	(Fail due to shortage of attendance and therefore, to repeat the course)

****

SEMESTER WISE STRUCTURE

SEMESTER I

S. No.	Course Code	Course Title	L	T	P	Credit
3 WEEKS COMPULSORY INDUCTION PROGRAM						
1	MT-101	Physics-I	3	1	3	5.5
2	MT-102	Mathematics-I	3	1	0	4
3	MT-103	Basic Electrical Engineering	3	1	2	5
4	MT-104	Engineering Graphics & Design	1	0	4	3
TOTAL			**10**	**3**	**9**	**17.5**

SEMESTER II

S. No.	Course Code	Course Title	L	T	P	Credit
1	MT-201	Chemistry-I	3	1	3	5.5
2	MT-202	Mathematics-II	3	1	0	4
3	MT-203	Programming for Problem Solving	3	0	4	5
4	MT-204	English	2	0	2	3
5	MT-211	Workshop/Manufacturing Practices	1	0	4	3
6	AU-102	Sports and Yoga	2^	0	0	0
TOTAL			12+2^	**2**	**13**	**20.5**
Mini Project or Internship (3-4 Weeks) shall be conducted during summer break after Semester II and will be assessed during Semester III.						

Note: ^ represents related to Audit Course.

SEMESTER III

S. No.	Course Code	Course Title	Weekly Contact Hours	L	T	P	C
1	MT-301	Basic Concepts of Mechatronics	3	3	0	0	3
2	MT-302	Strength of Materials	3	2	1	0	3
3	MT-303	Electrical Machines	3	3	0	0	3
4	MT-304	Physics-II	2	2	0	0	2
5	MT-305	Embedded Systems	3	3	0	0	3
6	MT-306	Effective Technical Communication	3	3	0	0	3
7	MT-311	Basic Mechatronics Lab	2	0	0	2	1

8	MT-312	Strength of Materials Lab	2	0	0	2	1
9	MT-313	Electrical Machines Lab	2	0	0	2	1
10	MT-314	Embedded Systems Lab	2	0	0	2	1
11	MT-315	Mini Project or Internship	-	-	-	-	1
12	HSMC(H - 102)	Universal Human Values 2: Understanding Harmony	3	2	1	0	3
TOTAL			**28**	**18**	**2**	**8**	**25**
Mini Project or Internship (3-4 Weeks) shall be conducted during summer break after Semester II and will be assessed during Semester III.							

SEMESTER IV

S.No.	Course Code	Course Title	Weekly Hours	L	T	P	C
1	MT-401	Fluid Mechanics	3	3	0	0	3
2	MT-402	Analog and Digital Electronics	3	3	0	0	3
3	MT-403	Computer Organization	3	3	0	0	3
4	MT-404	Signals & Systems	3	3	0	0	3
5	MT-405	Industrial Automation	3	3	0	0	3
7	AU-401	Environmental Science	2^	2^	0	0	0
8	MT-411	Fluid Mechanics Lab	4	0	0	4	2
9	MT-412	Analog and Digital Electronics Lab	2	0	0	2	1
10	MT-413	Industrial Automation Lab	4	0	0	4	2
11	MT-414	Signal & System Lab	2	0	0	2	1
12	MT-415	Industrial Visit	-	-	-	-	1
TOTAL			**27+2^**	**15+2^**	**0**	**12**	**22**

Mini Project or Internship (3-4 Weeks) shall be conducted during summer break after Semester IV and will be assessed during Semester V.
Note: ^ represent "Audit Course".

SEMESTER V

S. No.	Course Code	Course Title	Weekly Hours	L	T	P	C
1	MT-501	Digital Signal Processing	3	2	1	0	3
2	MT-502	Sensors & Instrumentation	3	2	1	0	3
3	MT-503	Control System Engineering	3	3	0	0	3
4	MT-504	Industrial Management	2	2	0	0	2
5	MT-505	Kinematics and Theory of Machines	3	3	0	0	3
6	MT-506	Entrepreneurship and Startups	3	3	0	0	3
7	AU-501	Indian Constitution	2^	2^	0	0	0
8	MT-511	Digital Signal Processing Lab	2	0	0	2	1
9	MT-512	Sensors & Instrumentation Lab	2	0	0	2	1
10	MT-513	Control System Engineering Lab	2	0	0	2	1
11	MT-514	Kinematics and Theory of Machines Lab	2	0	0	2	1
12	MT-515	Mini Project or Internship	-	-	-	-	1
TOTAL			**25+2^**	**15+2^**	**2**	**8**	**22**

Mini Project or Internship (3-4 Weeks) shall be conducted during summer break after Semester IV and will be assessed during Semester V.
^ represent "Audit Course".

SEMESTER VI

S. No.	Course Code	Course Title	Weekly Contact Hours	L	T	P	C
1	MT-601	Design of Machine Elements	3	3	0	0	3
2	MT-602	Computer Network & Cyber Security	3	3	0	0	3
3	MT-603	Microprocessor & Microcontroller	3	3	0	0	3
4	MT-604	Manufacturing Technologies	3	3	0	0	3
5	MTPE-60X	Professional Elective I	3	3	0	0	3
6	MT-611	Computer Aided Design Lab	4	0	0	4	2
7	MT-612	Computer Network & Cyber Security Lab	2	0	0	2	1
8	MT-613	Microprocessor & Microcontroller Lab	4	0	0	4	2
9	MT-614	Manufacturing Technologies Lab	2	0	0	2	1
10	MT-615	Seminar	-	-	-	-	1
TOTAL			**27**	**15**	**0**	**8**	**22**

Mini Project or Internship (3-4 Weeks) shall be conducted during summer break after Semester VI and will be assessed during Semester VII.

Any one course from following options can be opted under 'Professional Elective I':

1. Optimization Technique (MTPE-601)
2. Operation Research (MTPE-602)
3. Total Quality Management (MTPE-603)

SEMESTER VII

S. No.	Course Code	Course Title	Weekly Contact Hours	L	T	P	C
1	MT-701	Robotics	3	3	0	0	3

2	MT-702	Mechatronics System	3	2	1	0	3
3	MT-703	Computer Aided Manufacturing	3	3	0	0	3
4	MTPE-70X	Professional Elective II	3	3	0	0	3
5	MT-711	Robotics Lab	4	0	0	4	2
6	MT-712	Computer Aided Manufacturing Lab	2	0	0	2	1
7	MT-713	Project Work I	4	0	0	4	2
8	MT-714	Mini Project or Internship	-	-	-	-	1
TOTAL			**22**	**11**	**1**	**10**	**18**

Mini Project or Internship (3-4 Weeks) shall be conducted during summer break after Semester VI and will be assessed during Semester VII.

Any one course from following options can be opted under 'Professional Elective II':

1. Product Development (MTPE-701)
2. Rapid Prototyping (MTPE-702)
3. Machine Learning (MTPE-703)

SEMESTER VIII

S. No.	Course Code	Course Title	Weekly Contact Hours	L	T	P	C
1	MTOE-80X	Open Elective I	3	3	0	0	3
2	MTOE-80X	Open Elective II	3	3	0	0	3
3	MT-811	Project Work II	20	-	-	-	10
TOTAL			**26**	**6**	**0**	**20**	**16**

Any one course from following options can be opted under 'Open Elective I':

1. Virtual and Augmented Reality (MTOE-801)
2. Image Processing and Computer Vision (MTOE-802)
3. Wireless Network & Communication (MTOE-803)

Any one course from following options can be opted under 'Open Elective II':

1. Artificial Intelligence (MTOE-804)
2. Real Time System (MTOE-805)
3. Artificial Neural Network (MTOE-806)

*****

SEMESTER – I

SEMESTER I

Course Code	:	MT-101
Course Title	:	Physics- I
Number of Credits	:	5.5 (L: 3, T: 1, P: 3)
Course Category	:	MT
Course Contents in Physics **(Any One)**	:	**Anyone from the below options** i. Introduction to Electromagnetic Theory ii. Introduction to Mechanics iii. Quantum Mechanics for Engineers iv. Oscillation, Waves and Optics

Course Objectives: To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

Introduction to Electromagnetic Theory
Pre-requisites (if any): Mathematics course with vector calculus

Module I: Electrostatics in vacuum

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Faraday's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module II: Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module III: Magnetostatics

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module IV: Magnetostatics in a linear magnetic medium

Magnetization and associated bound currents; auxiliary magnetic field H; Boundary conditions on B and H. Solving for magnetic field due to simple magnets like a bar magnet;

magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module V: Faraday's law

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Module VI: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time dependent electric field; calculating magnetic field due to changing electric fields in quasistatic approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Pointing vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module VII: Electromagnetic waves

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Laboratory - Introduction to Electromagnetic Theory

Choice of experiments from the following:

- Experiments on electromagnetic induction and electromagnetic braking;
- LC circuit and LCR circuit;
- Resonance phenomena in LCR circuits;
- Magnetic field from Helmholtz coil;
- Measurement of Lorentz force in a vacuum tube.

TEXTBOOKS/REFERENCES:

1. David Griffiths, Introduction to Electrodynamics
2. Halliday and Resnick, Physics
3. W. Saslow, Electricity, magnetism and light

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTION TO ELECTROMAGNETIC THEORY	PROF. MANOJ HARBOLA	IIT KANPUR

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	LC circuit and LCR circuit;	1. http://vlab.amrita.edu/?sub=1&brch=75&sim=326&cnt=1 2. http://vlab.amrita.edu/?sub=1&brch=75&sim=330&cnt=1 3. http://vlab.amrita.edu/?sub=1&brch=75&sim=318&cnt=1 4. http://vlab.amrita.edu/?sub=1&brch=75&sim=325&cnt=1 5. http://vlabs.iitkgp.ernet.in/asnm/exp12/index.htm
2	Resonance phenomena in LCR circuits	http://vlab.amrita.edu/?sub=1&brch=75&sim=325&cnt=1

*****

Introduction to Mechanics
Pre-requisites (if any): High School Education

Module I

Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates.

Module II

Potential energy function; F = - Grad V, equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical, parabolic and hyperbolic orbits; Kepler problem; Application: Satellite manoeuvres;

Module III

Non-inertial frames of reference; Rotating coordinate system: Five-term acceleration formula. Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum;

Module IV

Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance.

Module V

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

Module VI

Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed — only need to show that this motion looks two-dimensional but is three-dimensional, and two-dimensional formulation fails.

Laboratory - Introduction to Mechanics

1. Suggested list of experiments from the following:
2. Coupled oscillators;
3. Experiments on an air-track;
4. Experiment on moment of inertia measurement,
5. Experiments with gyroscope;
6. Resonance phenomena in mechanical oscillators.

TEXTBOOKS/REFERENCES:

1. Engineering Mechanics, 2nd ed. — MK Harbola
2. Engineering Mechanics, 2nd ed. – D.S. Bedi & M.P. Poonia
3. Introduction to Mechanics — MK Verma
4. Elements of Mechanical Engineering - D.S. Bedi & M.P. Poonia
5. An Introduction to Mechanics — D Kleppner & R Kolenkow
6. Principles of Mechanics — JL Synge & BA Griffiths
7. Mechanics — JP Den Hartog
8. Engineering Mechanics - Dynamics, 7th ed. - JL Meriam
9. Mechanical Vibrations — JP Den Hartog
10. Theory of Vibrations with Applications — WT Thomson

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	ENGINEERING MECHANICS	PROF. MANOJ HARBOLA	IIT KANPUR

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Experiment on moment of inertia measurement.	https://vlab.amrita.edu/?sub=1&brch=74&sim=571&cnt=1

*****

Quantum Mechanics for Engineers
Pre-requisites (if any): Mathematics Course on Differential equations & linear algebra

Module I: Wave nature of particles and the Schrodinger equation
Introduction to Quantum mechanics, Wave nature of Particles, Time-dependent and time independent Schrodinger equation for wave function, Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle.

Module II: Mathematical Preliminaries for quantum mechanics
Complex numbers, Linear vector spaces, inner product, operators, eigenvalue problems, Hermitian operators, Hermite polynomials, Legendre's equation, spherical harmonics.

Module III: Applying the Schrodinger equation
Solution of stationary-state Schrodinger equation for one dimensional problems– particle in a box, particle in attractive delta-function potential, square-well potential, linear harmonic oscillator. Numerical solution of stationary-state Schrodinger equation for one dimensional problems for different potentials Scattering from a potential barrier and tunneling; related examples like alpha-decay, fieldionization and scanning tunneling microscope Three-dimensional problems: particle in three dimensional box and related examples, Angular momentum operator, Rigid Rotor, Hydrogen atom ground-state, orbitals, interaction with magnetic field, spin, Numerical solution stationary-state radial Schrodinger equation for spherically symmetric potentials.

Module IV: Introduction to molecular bonding
Particle in double delta-function potential, Molecules (hydrogen molecule, valence bond and molecular orbitals picture), singlet/triplet states, chemical bonding, hybridization.

Module V: Introduction to solids
Free electron theory of metals, Fermi level, density of states, Application to white dwarfs and neutron stars, Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands Numerical solution for energy in one-dimensional periodic lattice by mixing plane waves.

Laboratory - Quantum Mechanics for Engineers
Suggested list of experiments:

- Frank-Hertz experiment;
- photoelectric effect experiment;
- Recording hydrogen atom spectrum.

TEXTBOOKS/REFERENCES:

1. Eisberg and Resnick, Introduction to Quantum Physics
2. D. J. Griffiths, Quantum mechanics
3. Richard Robinett, Quantum Mechanics
4. Daniel McQuarrie, Quantum Chemistry

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTION TO ELECTROMAGNETIC THEORY	PROF. MANOJ HARBOLA	IIT KANPUR
2	QUANTUM MECHANICS I	PROF. P. RAMADEVI	IIT BOMBAY

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Photoelectric effect experiment.	http://mpv-au.vlabs.ac.in/modern-physics/Photo_Electric_Effect/

*****

Oscillations, waves and optics
Pre-requisites (if any): Mathematics Course on Differential equations

Module I: Simple harmonic motion, damped and forced simple harmonic oscillator
Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

Module II: Non-dispersive transverse and longitudinal waves in one dimension and introduction to dispersion
Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

Module III: The propagation of light and geometric optics
Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

Module IV: Wave optics

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer, Mach-Zehnder interferometer.

Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

Module V: Lasers

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

Laboratory - Oscillations, waves and optics

Suggested list of experiments from the following:

- Diffraction and interference experiments (from ordinary light or laser pointers); measurement of speed of light on a table top using modulation; minimum deviation from a prism.

TEXTBOOKS/REFERENCES:

1. Ian G. Main, Oscillations and waves in physics
2. H.J. Pain, The physics of vibrations and waves
3. E. Hecht, Optics
4. A. Ghatak, Optics
5. O. Svelto, Principles of Lasers

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	WAVES AND OSCILLATIONS	PROF. M. S. SANTHANAM	IISER PUNE

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Diffraction and interference experiments (from ordinary light or laser pointers).	http://ov-au.vlabs.ac.in/optics/Diffraction_Grating/
2	Minimum deviation from a prism.	http://ov-au.vlabs.ac.in/optics/Spectrometer_i_d_Curve/

*****

Course Code	:	MT-102
Course Title	:	Mathematics- I
Number of Credits	:	4 (L: 3, T: 1, P: 0)
Course Category	:	MT

Course Objectives: The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Contents:

Module I: Calculus
Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Module II: Sequences and Series
Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module III: Multivariable Calculus (Differentiation)
Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Module IV: Matrices
Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

TEXTBOOKS/REFERENCES:
1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.

4. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2015.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
6. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
7. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
8. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
9. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2018.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	ENGINEERING MATHEMATICS - I	PROF. JITENDRA KUMAR	IIT KGP

Course Outcomes: The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

The students will learn:

- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- To explain the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- To discuss the tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that are essential in most branches of engineering.
- To use the essential tool of matrices and linear algebra in a comprehensive manner.

*****

Course Code	:	MT-103
Course Title	:	Basic Electrical Engineering
Number of Credits	:	5 (L: 3, T: 1, P: 2)
Course Category	:	MT

Course Objective: The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Course Contents:

Module I: D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

Module II: Single Phase A.C. Circuits covering, Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

Module III: Transformers covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation;

Module IV: DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

Module V: Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Module VI: Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geo-thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation;

TEXT/REFERENCS BOOKS:

1. Ritu Sahdev (2018), Basic Electrical Engineering, Khanna Publishing House.
2. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
3. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
4. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
5. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India Hughes, E. 2005).

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	BASIC ELECTRIC CIRCUITS	PROF. ANKUSH SHARMA	IIT KANPUR
2	BASIC ELECTRICAL CIRCUITS	PROF. NAGENDRA KRISHNAPURA	IITM
3	FUNDAMENTALS OF ELECTRICAL ENGINEERING	PROF. DEBAPRIYA DAS	IIT KGP

COURSE OUTCOMES:
The students will learn:

1. To explain strong basics of Electrical Engineering and practical implementation of Electrical fundamentals.
2. To identify different applications of commonly used electrical machinery.

*****

Course Code	:	MT104
Course Title	:	Engineering Graphics & Design
Number of Credits	:	3 (L: 1, T: 0, P: 4)
Course Category	:	MT

Course Objective(s):
The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

Course Contents:
Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics: Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).
(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

Module I: Introduction to Engineering Drawing
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module II: Orthographic Projections

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module III: Projections of Regular Solids

Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module IV: Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).

Module V: Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Module VI: Overview of Computer Graphics

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module VII: Customization & CAD Drawing

Consisting of set up of the drawing page and the printer, including scale settings, setting up of Modules and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module VIII: Annotations, layering & other functions

Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid,

surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module IX: Demonstration of a simple team design project that illustrates
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text/Reference Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
2. Jain Pradeep, Gautam A.P., Maheshwari Ankita, Engineering Graphics and Design (2018), Khanna Publishing House, Delhi
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
6. (Corresponding set of) CAD Software Theory and User Manuals.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	PROF. RAJARAM LAKKARAJU	IIT KGP	ENGINEERING DRAWING AND COMPUTER GRAPHICS
2	PROF. NIHAR RANJAN PATRA	IIT KANPUR	ENGINEERING GRAPHICS

Course Outcomes:
All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

- to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- to prepare you to communicate effectively
- to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

The students will learn:

- To describe engineering design and its place in society.
- To discuss the visual aspects of engineering design.
- To use engineering graphics standards.
- To illustrate solid modelling.
- To use computer-aided geometric design.
- To design creating working drawings.
- To inspect engineering communication.

*****

SEMESTER – II

SEMESTER II

Course Code	:	MT-201
Course Title	:	Chemistry- I
Number of Credits	:	5.5 (L: 3, T: 1, P: 3)
Course Category	:	MT

Course Objective: The objective of the Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Course Content:

Module I: Atomic and Molecular Structure
Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Module II: Spectroscopic techniques and applications
Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

Module III: Intermolecular forces and potential energy surfaces
Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module IV: Use of free energy in chemical equilibria (6 lectures)
Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications.

Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Module V: Periodic properties
Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

Module VI: Stereochemistry
Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.

Module VII: Organic reactions and synthesis of a drug molecule
Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

LABORATORY
Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and emfs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.
11. Chemical analysis of a salt.
12. Lattice structures and packing of spheres.
13. Models of potential energy surfaces.
14. Chemical oscillations- Iodine clock reaction.
15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal.
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Text/Reference Books:

1. University chemistry, by B. H. Mahan
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
5. Physical Chemistry, by P. W. Atkins

6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	CHEMISTRY - I	PROF. MANGALA SUNDER KRISHNAN	IITM

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Determination of surface tension and viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Ion exchange column for removal of hardness of water.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Chemical_Parameters/
3	Determination of chloride content of water.	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Environmental_Engineering_1/experiments/determination-of-chloride-nitk/simulation.html
4	Colligative properties using freezing point depression.	http://pcv-au.vlabs.ac.in/physical-chemistry/Cryoscopy/
5	Determination of the rate constant of a reaction.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
6	Determination of cell constant and conductance of solutions.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Physical_Parameters/
7	Potentiometry - determination of redox potentials and emfs.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
8	Saponification/acid value of an oil.	http://biotech01.vlabs.ac.in/bio-chemistry/Estimation_of_Saponification_Value_of_Fats_or_Oils/
9	Lattice structures and packing of spheres.	https://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1

Course Outcomes: The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools.

Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometre levels, one has to base the description of all chemical processes at molecular levels. The course will enable the students:

- To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- To rationalise bulk properties and processes using thermodynamic considerations.
- To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
- To list major chemical reactions that are used in the synthesis of molecules.

Laboratory Outcomes: The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn:

- To estimate rate constants of reactions from concentration of reactants/products as a function of time.
- To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
- To synthesize a small drug molecule and analyze a salt sample.

*****

Course Code	:	MT-202
Course Title	:	Mathematics- II
Number of Credits	:	4 (L: 3, T: 1, P: 0)
Course Category	:	MT

Course Objective: Mathematics fundamental necessary to formulate, solve and analyze engineering problems.

Course Content:

Module I: Multivariable Calculus (Integration)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Module II: First order ordinary differential equations

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module III: Ordinary differential equations of higher orders

Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module IV: Complex Variable – Differentiation

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module V: Complex Variable – Integration

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

TEXT BOOKS/REFERENCES:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
4. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
5. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
7. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
10. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2018.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	DIFFERENTIAL EQUATIONS FOR ENGINEERS	PROF. SRINIVASA MANAM	IITM

2	ENGINEERING MATHEMATICS II	PROF. JITENDRA KUMAR	IIT KHARAGPUR

COURSE OUTCOMES: The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- To illustrate the mathematical tools needed in evaluating multiple integrals and their usage.
- To categories the effective mathematical tools for the solutions of differential equations that model physical processes.
- To explain the tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

*****

Course Code	:	MT-203
Course Title	:	Programming for Problem Solving
Number of Credits	:	5 (L: 3, T: 0, P: 4)
Course Category	:	MT

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyze the output based on the given input variables

Course Contents:

Module I: Introduction to Programming**;** Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Module II: Arithmetic expressions and precedence.

Module III: Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

Module IV: Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Module V: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module VI: Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Module VII: Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module VIII: Structures, Defining structures and Array of Structures

Module IX: Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Module X: File handling (only if time is available, otherwise should be done as part of the lab).

PRACTICALS:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

TEXT/REFERENCE BOOKS:

1. R.S. Salaria, Problem Solving & Programming in C, Khanna Publishing House.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	INTRODUCTION TO PROGRAMMING IN C	PROF. SATYADEV NANDAKUMAR	IITK

2	PROBLEM SOLVING THROUGH PROGRAMMING IN C	PROF. ANUPAM BASU	IIT KGP

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02-iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02-iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

COURSE OUTCOMES: The student will learn following through lectures:

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

The student will learn following through Practicals:

- To formulate the algorithms for simple problems.
- To translate given algorithms to a working and correct program.
- To be able to correct syntax errors as reported by the compilers.
- To be able to identify and correct logical errors encountered at run time.
- To be able to write iterative as well as recursive programs.
- To be able to represent data in arrays, strings and structures and manipulate them through a program.
- To be able to declare pointers of different types and use them in defining self-referential structures.
- To be able to create, read and write to and from simple text files.

*****

Course Code	:	MT-204
Course Title	:	English
Number of Credits	:	3 (L: 2, T: 0, P: 2)
Course Category	:	MT

Course Objective:

- To provide learning environment to practice listening, speaking, reading and writing skills.
- To assist the students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

Course Content:

Module I: Vocabulary Building

1.1. The concept of Word Formation
1.2. Root words from foreign languages and their use in English
1.3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
1.4. Synonyms, antonyms, and standard abbreviations.

Module II: Basic Writing Skills

1.1. Sentence Structures
1.2. Use of phrases and clauses in sentences
1.3. Importance of proper punctuation
1.4. Creating coherence
1.5. Organizing principles of paragraphs in documents
1.6. Techniques for writing precisely

Module III: Identifying Common Errors in Writing

1.1. Subject-verb agreement

1.2. Noun-pronoun agreement
1.3. Misplaced modifiers
1.4. Articles
1.5. Prepositions
1.6. Redundancies
1.7. Clichés

Module IV: Nature and Style of sensible Writing
1.1. Describing
1.2. Defining
1.3. Classifying
1.4. Providing examples or evidence
1.5. Writing introduction and conclusion

Module V: Writing Practices
1.1. Comprehension
1.2. Précis Writing
1.3. Essay Writing

Module VI: Oral Communication
(This Module involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Text/Reference Books:

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.
7. Effective Communication Skills. Kulbhushan Kumar. Khanna Publishing House. 2018.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	ENGLISH LANGUAGE FOR COMPETITIVE EXAMS	PROF. AYSHA IQBAL	IIT MADRAS
2.	TECHNICAL ENGLISH FOR ENGINEERS	PROF. AYSHA IQBAL	IITM

Course Outcomes: The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

*****

Course Code	:	MT-211
Course Title	:	Workshop/Manufacturing Practices
Number of Credits	:	3 (L: 1, T: 0, P: 4)
Course Category	:	MT

Course Objective:

1. To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
2. To have a study and hands-on-exercise on plumbing and carpentry components.
3. To have a practice on gas welding, foundry operations and fitting
4. To have a study on measurement of electrical quantities, energy and resistance to earth.
5. To have a practice on soldering.

Course Content:

Module I: Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
Module II: CNC machining, Additive manufacturing.
Module III: Fitting operations & power tools.
Module IV: Electrical & Electronics.
Module V: Carpentry.
Module VI: Plastic moulding, glass cutting.
Module VII: Metal casting.
Module VIII: Welding (arc welding & gas welding), brazing.

Practicals:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Suggested Text/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Welding shop (Arc welding + Gas welding).	http://mm-coep.vlabs.ac.in/LaserSpotWelding/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20Micromachining%20laboratory
2	Casting	http://fab-coep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&lab=Welcome%20to%20FAB%20laboratory

Course Outcomes: Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Laboratory Outcomes:

Upon completion of this laboratory course, students will be able:

- To fabricate components with their own hands.
- To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- To design small devices of their interest by assembling different components.

*****

Course Code	:	AU102
Course Title	:	Sports and Yoga
Number of Credits	:	0 (L: 2^, T: 0, P: 0)
Course Category	:	AU

Course Objective(s):

- To make the students understand the importance of sound health and fitness principles as they relate to better health.
- To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.
- To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.
- To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

Module I: Introduction to Physical Education

- Meaning & definition of Physical Education
- Aims & Objectives of Physical Education
- Changing trends in Physical Education

Module II: Olympic Movement

- Ancient & Modern Olympics (Summer & Winter)
- Olympic Symbols, Ideals, Objectives & Values
- Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

Module III: Physical Fitness, Wellness & Lifestyle

- Meaning & Importance of Physical Fitness & Wellness
- Components of Physical fitness
- Components of Health related fitness
- Components of wellness
- Preventing Health Threats through Lifestyle Change
- Concept of Positive Lifestyle

Module IV: Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga

- Define Anatomy, Physiology & Its Importance
- Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

Module V: Kinesiology, Biomechanics & Sports

- Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports
- Newton's Law of Motion & its application in sports.
- Friction and its effects in Sports.

Module VI: Postures

- Meaning and Concept of Postures.

- Causes of Bad Posture.
- Advantages & disadvantages of weight training.
- Concept & advantages of Correct Posture.
- Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
- Corrective Measures for Postural Deformities

Module VII: Yoga

- Meaning & Importance of Yoga
- Elements of Yoga
- Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas
- Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana)
- Relaxation Techniques for improving concentration - Yog-nidra

Module VIII: Yoga & Lifestyle

- Asanas as preventive measures.
- Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.
- Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.
- Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.
- Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana.
- Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

Module IX: Training and Planning in Sports

- Meaning of Training
- Warming up and limbering down
- Skill, Technique & Style
- Meaning and Objectives of Planning.
- Tournament – Knock-Out, League/Round Robin & Combination.

Module X: Psychology & Sports

- Definition & Importance of Psychology in Physical Edu. & Sports
- Define & Differentiate Between Growth & Development
- Adolescent Problems & Their Management
- Emotion: Concept, Type & Controlling of emotions
- Meaning, Concept & Types of Aggressions in Sports.
- Psychological benefits of exercise.
- Anxiety & Fear and its effects on Sports Performance.

- Motivation, its type & techniques.
- Understanding Stress & Coping Strategies.

Module XI: Doping

- Meaning and Concept of Doping
- Prohibited Substances & Methods
- Side Effects of Prohibited Substances

Module XII: Sports Medicine

- First Aid – Definition, Aims & Objectives.
- Sports injuries: Classification, Causes & Prevention.
- Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

Module XIII: Sports / Games

Following subtopics related to any one Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.

- History of the Game/Sport.
- Latest General Rules of the Game/Sport.
- Specifications of Play Fields and Related Sports Equipment.
- Important Tournaments and Venues.
- Sports Personalities.
- Proper Sports Gear and its Importance.

Text Books/References:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga By B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

Course Outcomes: On successful completion of the course the students will be able:

1. To practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation.
2. To learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
3. To learn breathing exercises and healthy fitness activities
4. To understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.
5. To perform yoga movements in various combination and forms.
6. To assess current personal fitness levels.
7. To identify opportModuleies for participation in yoga and sports activities.
8. To develop understanding of health-related fitness components: cardiorespiratory endurance, flexibility and body composition etc.
9. To improve personal fitness through participation in sports and yogic activities.

10. To develop understanding of psychological problems associated with the age and lifestyle.
11. To demonstrate an understanding of sound nutritional practices as related to health and physical performance.
12. To assess yoga activities in terms of fitness value.
13. To identify and apply injury prevention principles related to yoga and physical fitness activities.
14. To understand and correctly apply biomechanical and physiological principles elated to exercise and training.

****

SEMESTER – III

SEMESTER III

Course Code	:	MT-301
Course Title	:	Basic Concepts of Mechatronics
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective: This course aims at providing fundamental understanding about the basic elements of a mechatronics system, interfacing, and its practical applications.

Course Contents:

Module I: Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.

Module II: Sensors and transducers: classification, Development in Transducer technology, Opto- Electronics-Shaft encoders, CD Sensors, Vision System, etc.

Module III: Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems

Module IV: Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

Module V: Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

Text/Reference Books:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.).
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Mechatronics & Manufacturing Automation	Dr. Shrikrishna N. Joshi	IIT Guwahati

Course Outcomes: After undergoing this course the students is in a position to understand how mechatronics systems can be designed and developed.

*****

Course Code	:	MT-302
Course Title	:	Strength of Materials
Number of Credits	:	3 (L: 2; T: 1; P: 0)
Course Category	:	MT

Course Objective:

- To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads.
- To calculate the elastic deformation occurring in various simple geometries for different types of loading.

Course Contents:

Module I: Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

Module II: Beams and type's transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Module III: Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Module IV: Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Module V: Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

Text/Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. D.S. Bedi, Strength of Materials, Khanna Book Publishing, 2017.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi 2005.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Strength of Materials	Dr. Satish C Sharma	IIT Roorkee

Course Outcomes:

After completing the course, the students should be able:

- To recognize various types of loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components.
- To evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading.

*****

Course Code	:	MT-303
Course Title	:	Electrical Machines
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- Understand the concepts of magnetic circuits.
- Understand the operation of ac and dc machines.
- Analyze the differences in operation of different dc and ac machine configurations.

Course Contents:

Module I: DC Machines-I: Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF

equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Module II: DC Machines –II: Motoring and generation Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines.

Module III: Induction Machines: Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Module IV: Single-phase induction motors: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.

Module V: Synchronous machines: Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text/Reference Books:

1. A. E. Fitzgerald and C. Kingsley, “Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bhimbhra, “Electrical Machines”, Khanna Book Publishing House, 2018.
4. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current Machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.
7. P. S. Bhimbhra, “Power Electronics”, Khanna Publishers, 2017.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Electrical Machines	Prof. G. Bhuvaneshwari	IIT Delhi

Course Outcomes: At the end of this course, students will demonstrate the ability

1. To understand the concepts of rotating magnetic fields.
2. To understand the operation of ac and dc machines.
3. To analyze performance characteristics of ac and dc machines.

*****

Course Code	:	MT-304
Course Title	:	Physics-II
Number of Credits	:	2 (L: 2; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- The course will provide the students about the electronic Components diode, transistor.
- This will provide the students the knowledge of IC fabrication.
- It gives an imp. Information about the optoelectronic devices.
- This course offered a variety of diodes like zener diode.
- It will give the knowledge of switching circuit.

Course Contents:

Module I: Review of semiconductor physics E-k diagram, Density of states, Occupation probability, Fermi level and quasi-Fermi level (variation by carrier concentration and temperature); p-n junction, Metal-semiconductor junction (Ohmic and Schottky); Carrier transport, generation, and recombination; Semiconductor materials of interest for optoelectronic devices, bandgap modification, heterostructures; Lightsemiconductor interaction: Rates of optical transitions, joint density of states, condition for optical amplification.

Module II: Semiconductor light emitting diodes (LEDs) (6) Rate equations for carrier density, Radiative and non-radiative recombination mechanisms in semiconductors, LED: device structure, materials, characteristics, and figures of merit.

Module III: Semiconductor lasers (8) Review of laser physics; Rate equations for carrier- and photon-density, and their steady state solutions, Laser dynamics, Relaxation oscillations, Input-output characteristics of lasers. Semiconductor laser: structure, materials, device characteristics, and figures of merit; DFB, DBR, and vertical-cavity surface-emitting lasers (VECSEL), Tunable semiconductor lasers.

Module IV: Photodetectors (6) Types of semiconductor photodetectors -p-n junction, PIN, and Avalanche --- and their structure, materials, working principle, and characteristics, Noise limits on performance; Solar cells.

Module V: Low-dimensional optoelectronic devices (6) Quantum-well, -wire, and -dot based LEDs, lasers, and photodetectors.

Text/Reference Books:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
6. Online course: "Semiconductor Optoelectronics" by M R Shenoy on NPTEL.
7. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Gupta on NPTEL.

Course Outcomes: After the completion of the course, Students will be able

1. To learn IC fabrication using many circuits as for the electronic industry.
2. To demonstrate the conversion of energy, like light to electrical energy using Optoelectronic devices
3. To learn semiconductor devices in the electronic field.
4. To illustrate Zener diode to control the voltage.

*****

Course Code	:	MT-305
Course Title	:	Embedded Systems
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- To understand the elements of embedded system.
- The ability to interface different components of embedded system and its programming.

Course Contents: The concept of embedded systems design, embedded microcontroller cores, embedded memories. Examples of embedded systems, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub-system interfacing, interfacing with external systems, user interfacing. Design trade-offs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming and Applications", Penram Intl, 1996.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Embedded Systems	Prof. Shantanu Chaudhary	IIT Delhi

Course Outcomes: At the end of the course, students will demonstrate the ability:

1. To suggest design approach using advanced controllers to real-life situations.
2. To design interfacing of the systems with other data handling / processing systems.
3. To identify engineering constraints like energy dissipation, data exchange speeds etc.

*****

Course Code	:	MT-306
Course Title	:	Effective Technical Communication
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Content:

Module I: Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.

Module II: Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Human factors, Managing technical communication projects, time estimation, Single sourcing, Localization.

Module III: Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, taking notes; Complex problem solving; Creativity.

Module IV: Communication and Technical Writing- Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.

Module V: Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, Engineering ethics, managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, taking notes, Complex problem solving, Creativity.

Text/Reference Books:

1. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004.
2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843).
3. Effective Communication Skills. Kulbhushan Kumar. Khanna Publishing House. 2018.
4. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
5. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
6. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
7. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002.
8. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213).

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL ID	NPTEL Course Name	Instructor	Host Institute
1	102104061	INTRODUCTION TO PROFESSIONAL SCIENTIFIC COMMUNICATION	PROF. S. GANESH	IIT KANPUR

*****

Course Code	:	MT-311
Course Title	:	Basic Mechatronics Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective:

- To synergies the combination of mechanical, electronics, control engineering and computer.

- Providing a focused laboratory environment to the engineering students to apply and absorb Mechatronics concepts.
- To provide a common ground where students could perform experimental study regarding fundamental sequence control by utilizing various sensors and actuators.

List of Experiments:

For first year students- Students can perform set of experiments as given below:

1. Identification and familiarization of the following components: resistors, inductors, capacitors, diodes, transistors, LED's.
2. Familiarization with the following components: CRO, transformer, function generator, Multimeter, power supply.
3. Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors.
4. Familiarization with the following mechanical components: gears, gear train, bearings, couplings, tachometer
5. To study and design the PN junction diode and its use as half wave and full wave rectifier.
6. To design a voltage regulator using zener diode. Discuss the behavior of the regulator for various loads.
7. To verify truth tables of various logic gates and flip flops.
8. To study various sensors and transducers and compare with ideal characteristics.
9. To measure the characteristics of LVDT using linear displacement trainer kit.

Text/Reference Books:

1. Bolton, "Mechatronics", Pearson, Singapore.
2. Mahalik, "Principles, concepts and applications Mechatronics", TMH.
3. Ramesh Gaonkar, "Introduction to 8085-PENRAM", International Publishing.
4. Muzumdar, "Pneumatics" –Tata McGraw-Hill Education.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Identification and familiarization of the following components: resistors, inductors, capacitors, diodes, transistors, LED's.	1. http://vlabs.iitkgp.ernet.in/be/exp1/index.html 2. http://vlabs.iitkgp.ernet.in/be/exp3/index.html 3. http://vlabs.iitkgp.ernet.in/be/exp2/index.html 4. http://vlabs.iitkgp.ernet.in/be/exp5/index.html
2	Familiarization with the following electrical machines: Induction motors, DC motors, synchronous motors, single phase motors.	http://em-coep.vlabs.ac.in/Exp8/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines

3	To study and design the PN junction diode and its use as half wave and full wave rectifier.	http://ee-iitb.vlabs.ac.in/ee-iitb/exp1/index.html
4	To design a voltage regulator using zener diode. Discuss the behavior of the regulator for various loads.	http://vlab.amrita.edu/?sub=1&brch=282&sim=1207&cnt=1
5	To verify truth tables of various logic gates and flip flops.	1. http://vlab.amrita.edu/index.php?sub=59&brch=165&sim=903&cnt=2 2. http://cse15-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab
6	To measure the characteristics of LVDT using linear displacement trainer kit.	http://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab

Course Outcomes: After completing the course, students will be able:

1. To Identify the key elements of mechatronics system, representation into block diagram.
2. To apply knowledge of the concept of signal processing and signal conditioning for its industrial applications.
3. To analyze the requirements for a given industrial process and select the most appropriate Actuators, sensors, design circuit according to applications.
4. To understand the different logic gates, architecture of microprocessor and microcontroller for industrial applications.

*****

Course Code	:	MT-312
Course Title	:	Strength of Materials Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: Demonstrating the basic principles in the area of strength and mechanics of materials and structural analysis to the undergraduate students through a series of experiments is the objective of the strength of materials lab. Measuring the

properties of the materials such as impact strength, tensile strength, compressive strength, hardness, ductility is conducted in the lab.
Major Equipments Strength of Materials Lab: - Universal testing machine, Torsion testing machine, Impact testing machine, Brinell hardness testing machine, Rockwell hardness testing machine, etc.

List of Experiments:
1. Tension test
2. Bending tests on simply supported beam and Cantilever beam.
3. Torsion test
4. Hardness tests (Brinnel's and Rockwell)
5. Tests on closely coiled and open coiled springs
6. Compression test on wood or concrete
7. Impact test
8. Shear test

Text/Reference Books:
1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company, 2018.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata Mc GrawHill Publishing Co. Ltd., New Delhi 2005.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Tension test.	1. http://sm-nitk.vlabs.ac.in/exp13/index.html 2. http://sm-nitk.vlabs.ac.in/exp14/index.html
2	Bending tests on simply supported beam and Cantilever beam.	1. https://mdmv-nitk.vlabs.ac.in/exp2/index.html 2. https://mdmv-nitk.vlabs.ac.in/exp3/index.html 3. http://sm-nitk.vlabs.ac.in/exp11/index.html
3	Torsion test.	1. http://eerc01-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab! 2. http://sm-nitk.vlabs.ac.in/exp19/index.html
4	Hardness tests (Brinnel's and Rockwell)	1. http://eerc01-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to

		%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab! 2. http://sm-nitk.vlabs.ac.in/exp20/index.html
5	Tests on closely coiled and open coiled springs.	http://eerc01-iiith.vlabs.ac.in/exp8/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab!
6	Compression test on wood or concrete.	http://eerc01-iiith.vlabs.ac.in/exp2/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab!
7	Impact test.	1. http://eerc01-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials% 2. http://sm-nitk.vlabs.ac.in/exp5/index.html 3. http://sm-nitk.vlabs.ac.in/exp6/index.html
8	Shear test.	1. http://eerc01-iiith.vlabs.ac.in/exp3/Introduction.html?domain=Civil%20Engineering&lab=Welcome%20to%20Basic%20Engineering%20Mechanics%20and%20Strength%20of%20Materials%20lab! 2. http://sm-nitk.vlabs.ac.in/exp7/index.html 3. http://sm-nitk.vlabs.ac.in/exp8/index.html 4. http://sm-nitk.vlabs.ac.in/exp9/index.html

Course Outcomes: Upon completion of the course student should be able:

1. To Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
2. To Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
3. To Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.

*****

Course Code	:	MT-313
Course Title	:	Electrical Machines Lab

Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective:

- Understand the concepts of magnetic circuits and their applications.
- Understand the operation of ac and dc machines and their characteristic curves.
- Analyze the differences in operation of different dc and ac machine configurations.

List of Experiments:

1. Performance characteristics of a D.C. Shunt motor.
2. Speed control of dc shunt motor by varying armature circuit and field circuit method.
3. Load test of D.C. shunt motor.
4. Perform an open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.
5. Perform load test on a universal motor and determine the performance with dc/ac supply voltage.
6. Speed control of 3 phase Induction Motor.
7. Determination of the performance characteristics of a three-phase induction motor by load test.
8. Obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.

Text/Reference Books:

1. A. E. Fitzgerald and C. Kingsley, “Electric Machinery”, McGraw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bhimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
4. I. J. nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
5. A. S. Langsdorf, “Alternating current Machines”, McGraw Hill Education, 1984.
6. P. C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	To obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.	1. http://em-coep.vlabs.ac.in/Exp3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines 2. http://em-coep.vlabs.ac.in/Exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Electrical%20Machines!

Course Outcomes: Upon completion of the course student should be able:

1. To obtain performance characteristics of a D.C. Shunt motor.
2. To analyze speed control of dc shunt motor by varying armature circuit and field circuit method.
3. To perform an open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.
4. To perform load test on a universal motor and determine the performance with dc/ac supply voltage.
5. To Determine the performance characteristics of a three-phase induction motor by load test.
6. To obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.

*****

Course Code	:	MT-314
Course Title	:	Embedded Systems Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: The student should be made to:

- Learn the working of ARM processor.
- Understand the Building Blocks of Embedded Systems.
- Learn the concept of memory map and memory interface.
- Know the characteristics of Real Time Systems.
- Write programs to interface memory, I/Os with processor.
- Study the interrupt performance.

List of Experiments:

1. Study of ARM evaluation system.
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Interrupt performance characteristics of ARM and FPGA.
8. Flashing of LEDS.
9. Interfacing stepper motor and temperature sensor.
10. Interfacing the wireless Modules with ARM.

Text/Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.

3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Interfacing ADC and DAC.	1. http://vlabs.iitkgp.ernet.in/rtes/exp4/index.html 2. http://vlabs.iitkgp.ernet.in/rtes/exp3/index.html
2	Interfacing keyboard and LCD.	http://vlabs.iitkgp.ernet.in/rtes/exp9/index.html
3	Flashing of LEDs.	http://vlabs.iitkgp.ernet.in/rtes/exp11/index.htm

Course Outcomes: At the end of the course, a student will be able:

1. To Write programs in ARM for a specific Application.
2. To Interface memory and Write programs related to memory operations.
3. To Interface A/D and D/A convertors with ARM system.
4. To Write programme for interfacing keyboard, display, motor and sensor.
5. To Analyse the performance of interrupt.

*****

Course Code	:	MT-315
Course Title	:	Mini Project or Internship
Number of Credits	:	1
Course Category	:	MT

Mini Project or Internship of 3 to 4 Weeks shall be performed during summer break after semester II and will be assessed as part of Semester III.

During the summer vacations, after the 2nd Semester, students are required to be involved in Inter/ Intra Institution Activities viz.; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institution; contribution at incubation/ innovation /entrepreneurship cell of the Institution; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovations Council for e.g.: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

After completion of Mini-project or Internship the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period or while working on mini-project. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics.

Student's Diary and Internship Report should be submitted by the students along with attendance record and an evolution sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawing, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

*****

Course Code	:	HSMC (H-102)
Course Title	:	Universal Human Values 2: Understanding Harmony
Number of Credits	:	3 (L: 2; T: 1; P: 0)
Course Category	:	MT
Pre-requisites	:	None. Universal Human Values 1 (Desirable)

Human Values Courses: During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is to be augmented by this compulsory full semester foundation course.

Objective: The objective of the course is four fold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course topics: *The course has 28 lectures and 14 practice sessions in 5 modules:*

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of 'I' and harmony in 'I'.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence

as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:
   a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
   b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. to discuss the conduct as an engineer or scientist etc.

Readings: Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan,

Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Mode Of Conduct (L-T-P-C 2-1-0-3 or 2L:1T:0P 3 credits): Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self- observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations.

Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8- day FDP on Universal Human Values is deemed essential.

Assessment:
This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:
Assessment by faculty mentor: 10 marks
Self-assessment: 10 marks
Assessment by peers: 10 marks
Socially relevant project/Group Activities/Assignments: 20 marks Semester End Examination: 50 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Outcome of the Course: By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by
a) faculty-student or mentor-mentee programs throughout their time with the institution
b) Higher level courses on human values in every aspect of living. E.g. as a professional

*****

SEMESTER – IV

SEMESTER IV

Course Code	:	MT-401
Course Title	:	Fluid Mechanics
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- To learn about the application of mass and momentum conservation laws for fluid flows
- To understand the importance of dimensional analysis
- To obtain the velocity and pressure variations in various types of simple flows
- To analyze the flow in water pumps and turbines.

Course Content:

Module I: Definition of fluid, Newton's law of viscosity, Modules and Dimensions- Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

Module II: Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

Module III: Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis.

Module IV: Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle.

Module V: Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, Module quantities, performance curves for turbines – governing of turbines.

Text/Reference Books:

1. Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing.
2. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N.

Chadramouli, Oxford University Press, 2010
3. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
4. Fluid Mechanics, Sadhu Singh, Khanna Publishing House.
5. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
6. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, Mc Graw Hill

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Fluid Mechanics	Prof. S.K. Som	IIT KHARAGPUR

Course Outcomes: At the end of the course, a student will be able:
1. To analyze simple flow situations mathematically.
2. To evaluate the performance of pumps and turbines.

*****

Course Code	:	MT-402
Course Title	:	Analog and Digital Electronics
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective: This course will enable students to:
- Recall and Recognize construction and characteristics of JFETs and MOSFETs and differentiate with BJT
- Demonstrate and Analyze Operational Amplifier circuits and their applications
- Describe, Illustrate and Analyze Combinational Logic circuits, Simplification of Algebraic Equations using Karnaugh Maps and Quine McClusky Techniques.
- Describe and Design Decoders, Encoders, Digital multiplexers, Adders and Subtractors, Binary comparators, Latches and Master-Slave Flip-Flops.
- Describe, Design and Analyze Synchronous and Asynchronous Sequential
- Explain and design registers and Counters, A/D and D/A converters.

Course Content:

Module-I: Field Effect Transistors: Junction Field Effect Transistors, MOSFETs, Differences between JFETs and MOSFETs, Biasing MOSFETs, FET Applications, CMOS Devices. Wave-Shaping Circuits: Integrated Circuit(IC) Multi vibrators. Introduction to Operational Amplifier: Ideal v/s practical Op Amp, Performance Parameters, Operational Amplifier Application Circuits: Peak Detector Circuit, Comparator, Active Filters, Non Linear Amplifier, Relaxation Oscillator, Current-To-Voltage Converter, Voltage-To Current Converter.

Module-II: The Basic Gates: Review of Basic Logic gates, Positive and Negative Logic, Introduction to HDL. Combinational
Logic Circuits: Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets, Karnaugh Simplifications, Don't-care Conditions, Product-of-sums Method, Product-of-sums simplifications, Simplification by Quine-McClusky Method, Hazards and Hazard covers, HDL Implementation Models.

Module-III: Data-Processing Circuits: Multiplexers, Demultiplexers, 1-of-16 Decoder, BCD to Decimal Decoders, Seven Segment Decoders, Encoders, Exclusive-OR Gates, Parity Generators and Checkers, Magnitude Comparator, Programmable Array Logic, Programmable Logic Arrays, HDL Implementation of Data Processing Circuits. Arithmetic Building Blocks, Arithmetic Logic Module.

Module-IV: Flip- Flops: FLIP-FLOP Timing, JK Master-slave FLIP-FLOP, Switch Contact Bounce Circuits, Various Representation of FLIP-FLOPs, HDL Implementation of FLIP-FLOP.
Registers: Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In - Serial Out, Parallel In - Parallel Out, Universal Shift Register, Applications of Shift Registers, Register implementation in HDL.

Module-V: Counters: Decade Counters, Preset table Counters, Counter Design as a Synthesis problem, A Digital Clock, Counter Design using HDL.
D/A Conversion and A/D Conversion: Variable, Resistor Networks, Binary Ladders, D/A Converters, D/A Accuracy and Resolution, A/D Converter-Simultaneous Conversion, A/D Converter-Counter Method, Continuous A/D Conversion, A/D Techniques, Dual-slope A/D Conversion, A/D Accuracy and Resolution.

Text/Reference Books:

1. A.K. Main & Nakul Maini, Analog Electronics, Khanna Book Publishing House (2018).
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997).
3. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications.
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory.
5. William Kleitz, Digital Electronics, Prentice Hall International Inc.

Course Outcomes: At the end of this course students will demonstrate the ability to

1. To understand the current voltage characteristics of semiconductor devices.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand of the fundamental concepts and techniques used in digital processing circuits.
4. To analyze, design and implement sequential logic circuits.
5. To apply the fundamental knowledge of analog and digital electronics to get different types of analog to digitalized signal and vice-versa converters in real world.

*****

Course Code	:	MT-403
Course Title	:	Computer Organization
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective: To expose the students to the following:

1. How Computer Systems work & the basic principles.
2. Instruction Level Architecture and Instruction Execution.
3. The current state of art in memory system design.
4. How I/O devices are accessed and its principles.
5. To provide the knowledge on Instruction Level Parallelism.
6. To impart the knowledge on micro programming.
7. Concepts of advanced pipelining techniques.

Course Content:

Module I: Functional blocks of a computer: CPU, memory, input-output subsystems, control Module. Instruction set architecture of a CPU – registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study – instruction sets of some common CPUs.

Data representation: signed number representation, fixed and floating-point representations, character representation. Computer arithmetic – integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic.

Module II: Introduction to x86 architecture.

CPU control Module design: hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU.

Memory system design: semiconductor memory technologies, memory organization.

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, U.

Module III: Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.

Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Module IV: Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Text/Reference Books:

1. "Computer Organization and Design**:** The Hardware/Software Interface" 5thEdition by David A. Patterson and John L. Hennessy, Elsevier.
2. Computer Organization and Embedded Systems, 6thEdition by Carl Hamacher, McGraw Hill Higher Education.
3. "Computer Architecture and Organization", 3rdEdition by John P. Hayes, WCB/McGraw-Hill.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Computer Organization & Architecture: A Pedagogical Aspect	Dr. Arnab Sarkar	IIT Gowahati
2.	Computer Architecture & Organisation	Prof. Indranil Sengupta Prof. Kamalika Datta	IIT Kharagpur

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To design a single bus architecture of a computer and describe the function of the instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set.
2. To write assembly language program for specified microprocessor for computing 16-bit multiplication, division and I/O device interface (ADC, Control circuit, serial port communication).
3. To predict flowchart for Concurrent access to memory and cache coherency in Parallel Processors and describe the process.
4. To design a memory Module and analyze its operation by interfacing with the CPU.
5. To assess its performance, and apply design techniques to enhance performance using pipelining, parallelism and RISC methodology.

*****

Course Code	:	MT-404
Course Title	:	Signals And Systems
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective: The course will provide strong foundation on signals and systems which will be useful for creating foundation of communication and signal processing. The students will learn basic continuous time and discrete time signals and systems. Student

will understand application of various transforms for analysis of signals and systems both continuous time and discrete time. Students will also explore to power and energy signals and spectrum.

Course Content:

Module I: Basic definitions, Classification of signals and systems. Signal operations and properties. Basic continuous time signals, signal sampling and quantization, is cretization of continuous time signals, discrete time signals. Basic system properties, Representation of digital signals. Case study of different signals form communication and biomedical field.

Module II: Impulse response characterization and convolution integral for CT- LTI system, signal responses to CT-LTI system, properties of convolution, LTI system response properties from impulse response. (*Review of Laplace transform with reference to CT signals and systems.)

Module III: Impulse response characterization and convolution sum, Causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system. DT-LTI system properties from Impulse response. System analysis from difference equation model

Module IV: Representation of periodic functions, Fourier series, Frequency spectrum of a periodic signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform and its properties. Introduction to DTFT and DFT

Module V: The z-Transform, Convergence of z-Transform, Basic z-Transform, Properties of z-Transform, Inverse z-Transform and Solving difference equation using z-Transform

Text/Reference Books:

1. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall.
2. Signals and Systems by K. Gopalan, Cengage Learning (India Edition).
3. Signals and Systems by Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications.
4. Signals and Systems by Simon Haykin and Bary Van Veen, Wiley- India Publications.
5. Linear Systems and Signals by B.P.Lathi, Oxford University Press.
6. Signal, Systems and Transforms by Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education.
7. Digital Signal Processing Fundamentals and Applications by Li Tan, Elsevier, Academic Press.
8. Signal and Systems by Anand Kumar, 3rd Edition, PHI.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Signals & Systems	Prof. k.S. Venkatesh	IIT Kanpur
2.	Signals & Sytems	Prof. V.M. Gadre	IIT Bombay

Course Outcomes: After learning the course the students should be able:

- To Understand about various types of signals, classify them, analyze them, and perform various operations on them.
- To Understand about various types of systems, classify them, analyze them and understand their response behavior.
- To illustrate of transforms in analysis of signals and system.
- To rate signals and systems for observing effects of applying various properties and operations to Create strong foundation of communication and signal processing to be studied in the subsequent semester.

*****

Course Code	:	MT-405
Course Title	:	Industrial Automation
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective: This course focuses on understanding various components of state of art automation technologies encountered in modern manufacturing industries. This course introduces the practical methods of automatic control of machines, processes and systems. All major parts of a modern industrial control system will be described and their principles explained.

Course Content:

Module I: Factory Automation and Integration: Basic concepts, types of automation, automation strategies, automation technologies, applications around us and in manufacturing industries.

Module II: Design and Operation of Logic Control Circuits for Hydraulics and Pneumatics: Basic elements of hydraulics/pneumatics, fluid power control elements and standard graphical symbols for them, hydraulic & pneumatic cylinders, hydraulic & pneumatic valves for pressure, flow & direction control, Circuit design approach and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems. Hydraulics/pneumatic safety and their applications to clamping, traversing and releasing operations.

Module III: Design and Operation of Electro-Pneumatic Logic Control Circuits: Electro-pneumatic systems, solenoid valves, different sensors, factory automation sensors, electrical sensors, process automation sensors and their interfaces as per application criteria. Circuit design approach using relay logic circuits and real time examples; sequence operation of two/more than two cylinders as per the design

requirement to automate the systems. Electro pneumatic & electro hydraulic systems using relay logic circuits.

Module IV: Industrial Control Systems: Programmable Logic Controllers (PLC) based control system, programming languages & instruction set, ladder logic, functional blocks, structured text, and applications. Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA); motion controller, applications of RFID technology and machine vision.

Module V: Research Micro Projects: Students in a group will carry out micro project on design and implementation of an automatic modular system which can be useful in contemporary automation industries. The methodologies will be followed as first design and simulation of automated systems using Festo Fluid, SIM, SIROS, PLC software and then implementation by using pneumatic controls, electro-pneumatic controls, PLC and motion controls.

Text Books:

1. Groover, M. P., Automation, Production System & Computer Integrated Manufacturing, Pearson Education Asia (2009).
2. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
3. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).
4. Nakra, B. C., Theory and Applications of Automatic Controls, Revised 2nd Edition, New Age International Publishers (2014).
5. Morriss, S. B., Automated Manufacturing Systems, McGraw Hill (2006).
6. Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing.
7. Garry Dunning Programmable Logic Controller.
8. Programmable Logic Controllers by Frank Petruzella.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Industrial Automation & control	Prof. S. Mukhopadhyay	IIT Kharagpur

Course Outcomes:

1. To demonstrated the knowledge of various devices used for industrial automation and their application, which will help students in their projects and knowledge in industry.
2. To learn terms, history, functions and principles of fluid power components in this automation technologies course. Control tactics, hydraulic interpretation, component symbols, pneumatic drawings and pneumatic circuit design are also examined. Students explore actuators and fluid transmission devices as well as the causes and consequences of fluid contamination.
3. To explore the programming and implementation of programmable logic controllers. Topics include the theories and application of hardware selection, configuration,

math blocks and troubleshooting. Students run industry-related simulations for PLC hardware and networking, related mechanisms, external device and operating cycle.

4. To illustrate the circuits used for automatic process controls of industrial systems.

*****

Course Code	:	AU-401
Course Title	:	Environmental Science
Number of Credits	:	0 (L: 2; T: 0; P: 0)
Course Category	:	AU

Course Objective: People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished products.

- Solve various engineering problems applying ecosystem to produce eco – friendly products.
- Use relevant air and noise control method to solve domestic and industrial problems.
- Use relevant water and soil control method to solve domestic and industrial problems.
- To recognize relevant energy sources required for domestic and industrial applications.
- Solve local solid and e-waste problems.

Course Content:

Module I: Ecosystem

1. Structure of ecosystem, Biotic & Abiotic components.
2. Food chain and food web.
3. Aquatic (Lentic and Lotic) and terrestrial ecosystem.
4. Carbon, Nitrogen, Sulphur, Phosphorus cycle.
5. Global warming -Causes, effects, process, Green House Effect, Ozone depletion.

Module II: Air and, Noise Pollution

1. Definition of pollution and pollutant, Natural and manmade sources of air pollution (Refrigerants, I.C., Boiler).
2. Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator).
3. Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler.
4. Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000.

Module III: Water and Soil Pollution

1. Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation.
2. Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis).
3. Causes, Effects and Preventive measures of Soil Pollution: Causes-Excessive use of Fertilizers, Pesticides and Insecticides, Irrigation, E-Waste.

Module IV: Renewable sources of Energy

1. Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills.
2. Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilization and storage of biogas.
3. Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy.
4. New Energy Sources: Need of new sources. Different types new energy sources. Applications of (Hydrogen energy, Ocean energy resources, Tidal energy conversion.) Concept, origin and power plants of geothermal energy.

Module V: Solid Waste Management, ISO 14000 & Environmental Management

1. Solid waste generation- Sources and characteristics of: Municipal solid waste, E-waste, biomedical waste.
2. Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries. Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste.
3. Air quality act 2004, air pollution control act 1981 and water pollution and control act1996. Structure and role of Central and state pollution control board.
4. Concept of Carbon Credit, Carbon Footprint.
5. Environmental management in fabrication industry.
6. ISO14000: Implementation in industries, Benefits.

Text Books/References:

1. S.C. Sharma & M.P. Poonia, Environmental Studies, Khanna Publishing House, New Delhi.
2. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
3. Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and
4. Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07-062099-
5. Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000, ISBN 10: 0471144940.
6. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi
7. Rao, C. S., Environmental Pollution Control and Engineering, New Age International Publication, 2007, ISBN: 81-224-1835-X.

8. Rao, M. N.Rao, H.V.N, Air Pollution, Tata Mc-Graw Hill Publication, New delhi, 1988, ISBN: 0-07- 451871-8.
9. Frank Kreith, Jan F Kreider, Principles of Solar Engineering, McGraw-Hill, New York; 1978, ISBN: 9780070354760.
10. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.
11. Patvardhan, A.D, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978-81-7993-502-6
12. Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN: 077441206.
13. Keshav Kant, Air Pollution & Control, Khanna Publishing House, New Delhi (Edition 2018)

Open source software and website address:

1. www.eco-prayer.org
2. www.teriin.org
3. www.cpcp.nic.in
4. www.cpcp.gov.in
5. www.indiaenvironmentportal.org.in
6. www.whatis.techtarget.com
7. www.sustainabledevelopment.un.org
8. www.conserve-energy-future.com

Teachers should use the following strategies to achieve the various outcomes of the course.

- Different methods of teaching and media to be used to attain classroom attention.
- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- 15-20% of the topics which are relatively simpler of descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations.
- Micro-projects may be given to group of students for hand-on experiences.
- Encouraging students to visit to sites such as Railway station and research establishment around the institution.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL ID	NPTEL Course Name	Instructor	Host Institute
1	127105018	Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts	Prof. Brajesh Kumar Dubey	IIT KGP

Course Outcomes: At the end of the course student will be able:

1. To Understand the ecosystem and terminology and solve various engineering problems applying ecosystem knowledge to produce eco – friendly products.
2. To Understand the suitable air, extent of noise pollution, and control measures and acts.

3. To Understand the water and soil pollution, and control measures and acts.
4. To Understand different renewable energy resources and efficient process of harvesting.
5. To Understand Solid Waste Management, ISO 14000 & Environmental Management.

*****

Course Code	:	MT-411
Course Title	:	Fluid Mechanics Lab
Number of Credits	:	2 (L: 0; T: 0; P: 4)
Course Category	:	MT

Course Objective:

- To teach basic principles of fluid mechanics.
- To teach and apply physical and mathematical methods used in analyzing engineering applications involving fluids.

List of Experiments:

1. Measurement of viscosity
2. Determination of co-efficient of friction of flow in a pipe
3. Determination of minor losses in flow through pipes
4. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades
5. Calibration of flow measuring devices:
    a. Orifice plate meter
    b. Nozzle meter
    c. Venturimeter
    d. V-notch
6. Study of Pressure Measuring Devices
7. Performance on hydraulic turbines: a) Pelton wheel b) Francis turbine c) Kaplan turbine.
8. Performance on hydraulic pumps: a) Single stage and multi stage centrifugal pumps b) Reciprocating pump.
9. Venturimeter.

Text Books/References:

1. Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing.
2. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010
3. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
4. Fluid Mechanics, Sadhu Singh, Khanna Publishing House.
5. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
6. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, Mc Graw Hill

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Measurement of viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Determination of coefficient of friction of flow in a pipe.	http://fm-nitk.vlabs.ac.in/exp4/index.html
3	Determination of minor losses in flow through pipes.	https://mfts-iitg.vlabs.ac.in/PipeFlow.html
4	Calibration of flow measuring devices: Orifice plate meter, Nozzle meter, Venturimeter, V-notch.	http://virtual-labs.ac.in/fm-nitk/exp1/index.html
5	Performance on hydraulic turbines: a) Pelton wheel b) Francis turbine c) Kaplan turbine.	1. http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/kaplan-turbine/ 2. http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/pelton-turbine/ 3. http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/francis-turbine/
6	Performance on hydraulic pumps: a) Single stage and multi stage centrifugal pumps b) Reciprocating pump.	http://fmc-nitk.vlabs.ac.in/fluid-machinery-lab/exp/centrifugal-pump/
7	Venturimeter.	http://fm-nitk.vlabs.ac.in/exp5/index.html

Course Outcomes: At the end of the course student will be able:

1. To Understanding of basic physics of fluids.
2. To calculate and design engineering applications involving fluid.
3. To analyze flow of systems in terms of mass, momentum, and energy balance.
4. To assess Having knowledge about current research topics about fluid mechanics.

*****

Course Code	:	MT-412
Course Title	:	Analog and Digital Electronics Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective:

This course encompasses analog and digital electronic circuits from a circuit and monolithic (integrated circuit) implementation point of view. The objective of this course is to provide undergraduates with sufficient fundamental theoretical and practical knowledge to pursue advanced topics in analog and digital integrated circuits.

List of Experiments:

1. a. Design and construct a Schmitt trigger using Op-Amp for given UTP 1 and LTP values and demonstrate its working. b. Design and implement a Schmitt trigger using Op-Amp using a simulation package for two sets of UTP and LTP values and 3 demonstrate its working.
2. a. Design and construct a rectangular waveform generator (Op-Amp 5 relaxation oscillator) for given frequency. b. Design and implement a rectangular waveform generator (Op-Amp relaxation oscillator) using a simulation package and observe the change in frequency when all resistor values are doubled.
3. Design and implement a stable multivibrator circuit using 555 timers for a given frequency and duty cycle.
4. Design and implement Half adder, Full Adder, Half Subtractor, Full Subtractor using basic gates.
5. a. Given any 4-variable logic expression, simplify using Entered 16 Variable Map and realize the simplified logic expression using 8:1 multiplexer IC. b. Write the Verilog /VHDL code for an 8:1 multiplexer. Simulate 18 and verify it's working.
6. a) Design and implement code converter I) Binary to Gray II) Gray to Binary Code using basic gates.
7. Design and verify the Truth Table of 3-bit Parity Generator and 4-bit Parity Checker using basic logic gates with an even parity bit.
8. a. Realize a J-K Master/Slave Flip-Flop using NAND gates and verify its truth table. b. Write the Verilog/VHDL code for D Flip-Flop with positive-edge triggering. Simulate and verify it's working.

Text Books: Sedra Adel S and Smith Kenneth Carless, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.

Reference Books:

1. A.K. Main & Nakul Maini, Analog Electronics, Khanna Book Publishing House (2018).
2. A.S. Sedra & K.C.Smith, Microelectronics Circuits, Oxford University Press (1997)
3. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory
5. William Kleitz, Digital Electronics, Prentice Hall International Inc.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Design and implement Half adder, Full Adder, Half Subtractor, Full Subtractor using basic gates.	http://vlabs.iitkgp.ernet.in/dec/exp7/index.html
2	Design and implement code converter I) Binary to Gray II) Gray to Binary Code using basic gates.	https://he-coep.vlabs.ac.in/Experiment2/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab
3	Realize a J-K Master/Slave Flip-Flop using NAND gates and verify its truth table.	http://vlabs.iitkgp.ernet.in/dec/exp8/index.html

Course Outcomes: On the completion of this laboratory course, the students will be able:

1. To Use Various Electronic Devices like Cathode Ray Oscilloscope, Signal generators, Digital Trainer Kit, Multimeters and components like Resistors, Capacitors, Op amp and Integrated Circuit.
2. To Design and demonstrate various combinational logic circuits.
3. To Design and demonstrate various types of counters and Registers using Flipflops
4. To simulate package to design circuits.
5. To Understand the working and implementation of ALU.

*****

Course Code	:	MT-413
Course Title	:	Industrial Automation Lab
Number of Credits	:	2 (L: 0; T: 0; P: 4)
Course Category	:	MT

Course Objective:

- This lab imparts skill and knowledge on Industrial automation with an exclusive training on hardware and software components to automate industrial and commercial applications.
- Candidates are trained on automation products like PLC, HMI and SCADA to control and monitor the plant and machine.
- Programme are to be developed to enhance the skill set of the participants on Hardware & Programming basics and servicing.

List of Experiments:

1. Study hardware and software used in PLC.
2. Implementation of logic gates in PLC.
3. Implementation of arithmetic instruction.
4. Implementation of on and off delay timers.
5. Study, understand and perform experiments on timers and counters.
6. Study and simulate analog function blocks.
7. Logic implementation for traffic control application.
8. Logic implementation for bottle filling application.
9. Direct control of double acting cylinder.
10. Indirect control of double acting cylinder.
11. Hydraulic pump/characteristic curve of variable displacement pump.
12. Single-rod cylinder/pressure intensification.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Study and simulate analog and digital function blocks.	http://ial-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
2	Study, understand and perform experiments on timers and counters.	http://ial-coep.vlabs.ac.in/Expt3/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory
3	Logic implementation for traffic control application.	http://ial-coep.vlabs.ac.in/Expt4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory
4	Logic implementation for bottle filling application.	http://ial-coep.vlabs.ac.in/Expt5/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Industrial%20Automation%20Laboratory
5	Study hardware and software used in PLC.	http://plc-coep.vlabs.ac.in/exp1/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab

6	Implementation of logic gates in PLC.	http://plc-coep.vlabs.ac.in/exp2/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab
7	Implementation of arithmetic instruction.	http://plc-coep.vlabs.ac.in/exp7/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab
8	Implementation of on and off delay timers.	http://plc-coep.vlabs.ac.in/exp4/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Programmable%20Logic%20Controller%20Lab

Text Books:

1. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
2. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).
3. Nakra, B. C., Theory and Applications of Automatic Controls, Revised 2nd Edition, New Age International Publishers (2014).
4. Garry Dunning: Programmable Logic Controller.

Course Outcomes:

1. To demonstrate the knowledge of various devices used for industrial automation and their application, which will help students in their projects and knowledge in industry.
2. To explain history, functions and principles of fluid power components in this automation technologies course. Control tactics, hydraulic interpretation, component symbols, pneumatic drawings and pneumatic circuit design are also examined. Students explore actuators and fluid transmission devices as well as the causes and consequences of fluid contamination.
3. To explore the programming and implementation of programmable logic controllers. Topics include the theories and application of hardware selection, configuration, math blocks and troubleshooting. Students run industry-related simulations for PLC hardware and networking, related mechanisms, external device and operating cycle.

*****

Course Code	:	MT-414
Course Title	:	Signals and Systems Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective:

1. To enable the student on how to approach solving Engineering problems using simulation tools.
2. To prepare the students to use and analyze MATLAB or other related softwares in their project works.
3. To provide a foundation in use of this software for real time applications.

List of Experiments:

1. Basic Operations on Matrices.
2. Generation of Various Signals and Sequences (Periodic and Aperiodic), such as Module Impulse, Module Step, Square, Saw tooth, Triangular, Sinusoidal, Ramp, Sinc.
3. Operations on Signals and Sequences such as Addition, Multiplication, Scaling, Shifting, Folding, Computation of Energy and Average Power.
4. Finding the Even and Odd parts of Signal/Sequence and Real and Imaginary parts of Signal.
5. Convolution between Signals and sequences.
6. Auto Correlation and Cross Correlation between Signals and Sequences.
7. Verification of Linearity and Time Invariance Properties of a given Continuous/Discrete System.
8. Computation of Module sample, Module step and Sinusoidal responses of the given LTI system and verifying its physical realizability and stability properties.
9. Gibbs Phenomenon.
10. Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum.

Text Books/References: Institutes may design their own Lab Manual; MATLAB Math works software or any other related software may be used.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Finding the Even and Odd parts of Signal/Sequence and Real and Imaginary parts of Signal.	http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties(objectives).html
2	Convolution between Signals and sequences.	http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205(objectives).html
3	Auto Correlation and Cross Correlation between Signals and Sequences.	http://ssl-iitg.vlabs.ac.in/Signals%20and%20their%20properties%205(objectives).html
4	Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum.	http://ssl-iitg.vlabs.ac.in/Signals_exp3(objectives).html

Course Outcomes: At the end of the course student will demonstrate:

1. Ability to express programming & simulation for engineering problems.
2. Ability to find importance of this software for Lab Experimentation.
3. Articulate importance of software's in research by simulation work.
4. Ability to write basic mathematical, electrical, electronic problems in MATLAB.

*****

Course Code	:	MT-415
Course Title	:	Industrial Visit
Number of Credits	:	1
Course Category	:	MT

The objective of an industrial visit is to provide opportModuley to students to get an insight regarding internal working of companies. Industrial visit helps to combine theoretical knowledge with practical knowledge. Industrial visits may be organized in any of the nearby industries interested to share their processes with students for their learning.

*****

SEMESTER – V

SEMESTER V

Course Code	:	MT-501
Course Title	:	Digital Signal Processing
Number of Credits	:	3 (L: 2; T: 1; P: 0)
Course Category	:	MT

Course Objective:

1. To learn the basic concepts and properties of discrete time signals and system.
2. To learn the frequency domain characteristics of discrete time signals and systems.
3. To design and implement digital filter design techniques.

Course Contents:

Module I: Discrete-time signals and systems

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Module II: Z-transform

z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Module III: Discrete Fourier Transform

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Module IV: Design of Digital filters

Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band- stop and High-pass filters.

Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Module V: Applications of Digital Signal Processing

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text Books/References:

1. S.K. Mitra, Digital Signal Processing: A computer based approach.TMH
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, 1997.
4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.

5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. D.J. DeFatta, J. G. Lucas and W.S.Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Digital Signal Processing	C.S Ramalingam	IIT Madras
2.	Digital Signal Processing	Prof. S.C Dutta	IIT Delhi

Course Outcomes: At the end of the course student will be able:

1. To Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. To Analyze discrete-time systems using z-transform.
3. To Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. To Design digital filters for various applications.
5. To Apply digital signal processing for the analysis of real-life signals.

*****

Course Code	:	MT-502
Course Title	:	Sensors & Instrumentation
Number of Credits	:	3 (L: 2; T: 1; P: 0)
Course Category	:	MT

Course Objective: The course provides good knowledge of working of different types of sensors used in various application areas. The course also provides knowledge of interfacing of electronic circuits with different sensors for its applications in different fields.

Course Contents:

Module I: Sensors Fundamentals and Characteristics: Sensors, Signals and Systems; Sensor Classification; Modules of Measurements; Sensor Characteristics.

Module II: Physical Principles of Sensing: Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

Module III: Interface Electronic Circuits: Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

Module IV: Sensors in Different Application: Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.

Module V: Sensor Materials and Technologies: Materials, Surface Processing, Nano-Technology.

Text Books/References:

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer.
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

Course Outcomes:

1. To Understand the concept of sensors and its characteristics.
2. To Understand the practical approach in design of technology based on different sensors
3. To Learn various sensor materials and technology used in designing sensors.
4. To demonstrate different sensors work
5. To Develop a sense for recognizing bad data and an intuition of how to resolve problems.

*****

Course Code	:	MT-503
Course Title	:	Control System Engineering
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- To teach the fundamental concepts of control systems & mathematical modelling of system.
- To study the concept of time response and frequency response of the system.
- To teach the basics of stability analysis of 6the system.

Course Contents:

Module-I: Introduction to control problem- Industrial Control examples. Transfer function. System with dead-time. System response. Control hardware and their models: potentiometers, synchro's, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis.

Module-II: Feedback control systems- Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feed- forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion.

Module-III: Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

Module-IV: Frequency-response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency- domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers. State variable formulation and solution.

Module-V: State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.
Introduction to Optimal control & Nonlinear control, Optimal Control problem, Regulator problem, Output regulator, trekking problem. Nonlinear system – Basic concept & analysis.

Text Books/References:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
4. Nagrath & Gopal, "Modern Control Engineering", New Age International, New Delhi.
5. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Control Systems	Prof. C.S Shankar Ram	IIT Madras

Course Outcomes: At the end of this course, students will demonstrate the ability:

1. To Understand the modelling of linear invariant systems using transfer function and state space representations.
2. To Understand the concept of stability and its assessment for linear time invariant systems.
3. To Design simple feedback controllers.

*****

Course Code	:	MT-504
Course Title	:	Industrial Management
Number of Credits	:	2 (L: 2; T: 0; P: 0)
Course Category	:	MT

Course Objective: The aim of the course is to understand the basic principles of management, and the four major functions of managers e.g. planning, organizing, leading and controlling and how managers actually operate. Students will be required to think critically and strategically about management theories and issues which will enable them to develop their decision-making and analytical skills. They will be involved in application exercises and case studies which will assist them to develop graduate attributes.

Course Contents:

Module-I: Introduction: Concept and scope of Industrial Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership.
Functions of Management, Taylor's Scientific Management Theory, Fayol's Principles of Management, Social responsibilities of Management,

Module-II: Introduction to Human resources management: Nature of HRM, functions and importance of HRM.

Work Study: Introduction, definition, objectives, steps in work study, Method study: definition, objectives, steps of method study, Work Measurement: purpose, types of study stop watch methods steps allowances standard time calculations work sampling,

Module-III: Production Planning and Control Inventory Control: Inventory, Cost, Models of inventory control: EOQ, ABC, VED. Quality Control: statistical quality control, Control charts for variables and attributes, Acceptance Sampling- Single sampling- Double sampling plans, Introduction to TQM.

Module-IV: Project Planning & Scheduling Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, event slacks & floats, PERT model, expected time for activities, expected length of critical path, calculating the project length and variance, PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique.

Module-V: Modification & Extensions of Network Models Complexity of project scheduling with limited resources, resource leveling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking- examples with algorithm, decision networks, probabilistic networks, computer aided project management essential requirements of PM software, software packages for CPM. Enterprise- wide PM, using spread sheets for financial projections.

Text Books/References:

1. Engineering Management (Industrial Engineering & Management), S.C. Sharma & T.R. Banga, Khanna Book Publishing Co. (P) Ltd., Delhi (ISBN: 978-93-86173-072)
2. Industrial Engineering and Management, P. Khanna, Dhanpat Rai publications Ltd.
3. Production & Operation Management, Paneer Selvam, PHI.
4. Industrial Engineering Management, NVS Raju, Cengage Learning.
5. Industrial Engineering Management, Ravi Shankar, Galgotia.

Course Outcomes:

Student is able:

1. To apply principles of management in his / her extra and co-curricular activity in college and in industrial in-plant training.
2. To apply work improvement techniques in an organization where he undergoes for in-plant training.
3. To compare & find out and reduce work content of the job.

*****

Course Code	:	MT-505
Course Title	:	Kinematics and Theory of Machines
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- To understand the kinematics and rigid body dynamics of kinematically driven machine components.
- To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.
- To be able to design some linkage mechanisms and cam systems to generate specified output motion.
- To understand the kinematics of gear trains.

Course Contents:

Module I: Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.

Module II: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis

using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics.

Module III: Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.

Module IV: Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

Module V: Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes.

Text Books:

1. Thomas Bevan, Theory of Machines, 3rdedition, CBS Publishers & Distributors,2005.
2. Cleghorn W.L., Mechanisms of Machines, Oxford University Press,2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill,2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Kinematics of Machines	Prof. Ashok K Mallik	IIT KANPUR

Course Outcomes: After completing this course, the students can design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning.

*****

Course Code	:	MT-506
Course Title	:	Entrepreneurship and Startups
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	HS

Course Objective:

- Acquiring Entrepreneurial spirit and resourcefulness.

- Familiarization with various uses of human resource for earning dignified means of living.
- Understanding the concept and process of entrepreneurship - its contribution and role in the growth and development of individual and the nation.
- Acquiring entrepreneurial quality, competency, and motivation.
- Learning the process and skills of creation and management of entrepreneurial venture.

Course Content:

Module I: Introduction to Entrepreneurship and Start – Ups

- Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation
- Types of Business Structures, Similarities/differences between entrepreneurs and managers.

Module II: Business Ideas and their implementation

- Discovering ideas and visualizing the business
- Activity map
- Business Plan

Module III: Idea to Start-up

- Market Analysis – Identifying the target market,
- Competition evaluation and Strategy Development,
- Marketing and accounting,
- Risk analysis

Module IV: Management

- Company's Organization Structure,
- Recruitment and management of talent.
- Financial organization and management

Module V: Financing and Protection of Ideas

- Financing methods available for start-ups in India
- Communication of Ideas to potential investors – Investor Pitch
- Patenting and Licenses

Module VI: Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy.

Text Books/References:

S. No.	Title of Book	Author	Publication
1	The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN – 978-0984999392
2	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN – 978-0670921607
3	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN – 978-0755388974

4	The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business	Clayton M. Christensen	Harvard business ISBN: 978-142219602

Websites:

1. https://www.fundable.com/learn/resources/guides/startup
2. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate-structure/
3. https://www.finder.com/small-business-finance-tips
4. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

Course Outcomes: Upon completion of the course, the student will be able:

1. To Understand the dynamic role of entrepreneurship and small businesses
2. To Organize and Managing a Small Business
3. To do Financial Planning and Control
4. To Forms of Ownership for Small Business
5. To develop Strategic Marketing Planning
6. To illustrate New Product or Service Development
7. To illustrate Business Plan Creation

*****

Course Code	:	AU-501
Course Title	:	Indian Constitution
Number of Credits	:	0 (L: 2; T: 0; P: 0)
Course Category	:	AU

Course Content

Module I: **The Constitution - Introduction**

- The History of the Making of the Indian Constitution
- Preamble and the Basic Structure, and its interpretation
- Fundamental Rights and Duties and their interpretation
- State Policy Principles

Module II – Union Government

- Structure of the Indian Union
- President – Role and Power
- Prime Minister and Council of Ministers
- Lok Sabha and Rajya Sabha

Module III – State Government

- Governor – Role and Power
- Chief Minister and Council of Ministers
- State Secretariat

Module IV – Local Administration

- District Administration

- Municipal Corporation
- Zila Panchayat

Module V – Election Commission

a. Role and Functioning
b. Chief Election Commissioner
c. State Election Commission

Text Books/Suggested Learning Resources:

S. No.	Title of Book	Author	Publication
1	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008
2	The Constitution of India	B.L. Fadia	Sahitya Bhawan; New edition (2017)
3	Introduction to the Constitution of India	DD Basu	Lexis Nexis; Twenty-Third 2018 edition

Suggested Software/Learning Websites:

1. https://www.constitution.org/cons/india/const.html
2. http://www.legislative.gov.in/constitution-of-india
3. https://www.sci.gov.in/constitution
4. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL ID	NPTEL Course Name	Instructor	Host Institute
1	12910600	CONSTITUTION OF INDIA AND ENVIRONMENTAL GOVERNANCE: ADMINISTRATIVE AND ADJUDICATORY PROCESS	PROF. SAIRAM BHAT, PROF. M. K. RAMESH	NATIONAL LAW SCHOOL OF INDIA UNIVERSITY

Course Outcomes: Upon completion of this course, the students will be able:

1 To Understand the emergence and evolution of Indian Constitution.
2 To Understand the structure and composition of Indian Constitution
3 To Understand and analyse federalism in the Indian context.
4 To Analyse Panchayati Raj institutions as a medium of decentralization
5 To Understand and analyse the three organs of the state in the contemporary scenario.
6 To Understand and Evaluate the Indian Political scenario amidst the emerging challenges.

*****

Course Code	:	MT-511
Course Title	:	Digital Signal Processing Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: The objective of the course is practical implementation of the convolution, correlation, DFT, IDFT, Block convolution, Signal smoothing, filtering of long duration signals, and Spectral analysis of signals.

List of Experiments:

1. To study about DSP Processors and its architecture.
2. Introduction to MATLAB and IDE for processor development.
3. Introduction to Scilab Open Source Software.
4. Write a Program for the generation of basic signals such as Module impulse, Module step, ramp, exponential, sinusoidal and cosine.
5. To study matrix multiplication using code composer studio.
6. Evaluate 4 point DFT of and IDFT of $x(n) = 1, 0 \leq n \leq 3; 0$ elsewhere.
7. To implement the FFT algorithm.
8. Verify Blackman and Hamming windowing techniques.
9. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
10. Verify Circular Convolution using code composer studio.
11. Verify Linear convolution of two sequences using code composer studio.
12. To implement Tone Generation.
13. To implement floating point arithmetic.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.	http://vlabs.iitkgp.ernet.in/dsp/exp10/index.html

Text Books/References:

1. John G. Proakis, "Digital signal processing: principles algorithms and applications Using Matlab". Pearson Education India.
2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach, 2nd edition, Tata McGraw-Hill.
3. Alan V, Oppenheim, Ronald W., Schafer A. "Digital Signal Processing" PHI Publishers.

Course Outcomes: After studying this course the students would be able:

1. To Understand the handling of discrete/digital signals using MATLAB & related softwares.
2. To Understand the basic operations of Signal processing.
3. To Analyze the spectral parameter of window functions.

4. To Design IIR, and FIR filters for band pass, band stop, low pass and high pass filters.
5. To develop the signal processing algorithm using MATLAB & VLAB.

*****

Course Code	:	MT-512
Course Title	:	Sensors & Instrumentation Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: This introduces the students with the theory and methods for conducting experimental work in the laboratory and calibration of various instruments for measuring pressure, temperature, displacement, speed, vibration etc.

List of Experiments:

1. Study of the characteristics of Capacitor Level Sensor for Level Measurement of a Liquid in a Tank.
2. Study of the characteristics of a Piezo Resistive Sensor for Pressure Measurement of a Liquid in a Tank.
3. Study of the characteristics of Resistance Temperature Detector (RTD)
4. Study of the characteristics of a Thermistor
5. Study of the characteristics of a Thermocouple
6. Study of the characteristics of a Magnetic Proximity sensor for Speed Measurement
7. Study of the characteristics and operation of Magnetic Sensor.
8. Study of the operation and characteristics of optical sensors

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Study of the characteristics of Capacitor Level Sensor for Level Measurement of a Liquid in a Tank.	http://sl-coep.vlabs.ac.in/Capacitance/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab
2	Study of the characteristics of Resistance Temperature Detector (RTD).	http://sl-coep.vlabs.ac.in/Rtd/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab
3	Study of the characteristics of a Thermistor.	http://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1

4	Study of the characteristics of a Thermocouple.	http://sl-coep.vlabs.ac.in/Thermocouple/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab

Text Books/References:

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

Course Outcomes:

1. To Understand the concept of sensors and its characteristics.
2. To Understand the practical approach in design of technology based on different sensors
3. To Learn various sensor materials and technology used in designing sensors.
4. To describe different sensors working.
5. To Develop a sense for recognizing bad data and an intuition of how to resolve problems.

*****

Course Code	:	MT-513
Course Title	:	Control System Engineering Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: To understand concepts of the mathematical modelling, feedback control and stability analysis in Time and Frequency domains.

List of Experiments:

1. Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox or its equivalent open source freeware software like Scilab.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for a given closed loop system in block diagram representation.
5. Plot Module step response of given transfer function and find delay time, rise time, peak time and peak overshoot.
6. Determine the time response of the given system subjected to any arbitrary input.
7. Plot root locus of given transfer function, locate closed loop poles for different values of k. Also find out Wd and What for a given root.

8. Create the state space model of a linear continuous system.
9. Determine the State Space representation of the given transfer function.
10. Plot bode plot of given transfer function. Also determine the relative stability by measuring gain and phase margins.
11. Determine the steady state errors of a given transfer function.
12. Plot Nyquist plot for given transfer function and to discuss closed loop stability. Also determine the relative stability by measuring gain and phase margin.

Text Books/References:

1. Gopal, M., Digital Control System, Wiley Eastern (1986).
2. Nagrath, I.J. and Gopal, M., Control System Engineering, New Age International (P) Limited, Publishers (2003). Hall of India Private Limited (2001).
3. Ogata, K., Modern Control Engineering, Prentice.
4. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.

Course Outcomes:

After the successful completion of the course the students will be able:

1. To Develop the mathematical model of the physical systems.
2. To Analyze the response of the closed and open loop systems.
3. To Analyze the stability of the closed and open loop systems.
4. To Design the various kinds of compensator.
5. To Develop and analyze state space models.

*****

Course Code	:	MT-514
Course Title	:	Kinematics and Theory of Machines Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective:

1. To develop skills for designing and analyzing linkages, cams, gears and other mechanisms.
2. To develop skills for use of mathematics software and for writing computer programs to solve kinematics problems.
3. To provide a foundation for the study of machine design.
4. Development of individual and team skills involving pre- and post-processing and interpretation computer-aided design and analysis data.
5. Development of individual and team communications skills.

List of Experiments:

1. Study of simple linkage models/mechanisms.
2. Study of inversions of four bar linkage.
3. Study of inversions of single/double slider crank mechanisms.
4. Experiment on Gears tooth profile, interference etc.

5. Experiment on Gear trains.
6. Experiment on longitudinal vibration.
7. Experiment on transverse vibration.
8. Experiments on dead weight type governor.
9. Experiment on spring controlled governor.
10. Experiment on critical speed of shaft.
11. Experiment on gyroscope.
12. Experiment on Cam profile.

Text Books/References:

1. Norton Dynamics of Machinery McGraw-Hill.
2. Recommended Software: Math CAD.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Study of simple linkage models/mechanisms.	http://mm-nitk.vlabs.ac.in/exp25/index.html
2	Study of inversions of four bar linkage.	http://mm-nitk.vlabs.ac.in/exp4/index.html
3	Study of inversions of single/double slider crank mechanisms.	1. http://mm-nitk.vlabs.ac.in/exp14/index.html 2. http://mm-nitk.vlabs.ac.in/exp13/index.html

Course Outcomes:

After the successful completion of the course the students will be able:

1. To Distinguish kinematic and kinetic motion.
2. To Identify the basic relations between distance, time, velocity, and acceleration.
3. To Apply vector mechanics as a tool for solving kinematic problems.
4. To Create a schematic drawing of a real-world mechanism.

*****

Course Code	:	MT-515
Course Title	:	Mini Project or Internship
Number of Credits	:	1
Course Category	:	MT

Mini Project or Internship of 3 to 4 Weeks shall be performed during summer break after semester IV and will be assessed as part of Semester V.

During the summer vacations, after the 4th Semester, students are required to be involved in Inter/ Intra Institution Activities viz.; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institution; contribution at incubation/ innovation /entrepreneurship cell of the Institution; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovations Council for e.g.: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

After completion of Mini-project or Internship the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period or while working on mini-project. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics.

Student's Diary and Internship Report should be submitted by the students along with attendance record and an evolution sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawing, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

*****

SEMESTER – VI

SEMESTER VI

Course Code	:	MT-601
Course Title	:	Design of Machine Elements
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

1. To develop an ability to apply knowledge of mathematics, science, and engineering.
2. To develop an ability to design a system, components to meet desired needs within realistic constraints.
3. To develop an ability to identify, formulate and solve engineering problems.
4. To develop an ability to use the technique, skills, & engineering tools.

Course Content:

Module-I: Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure),

Module-Ii: Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings,

Module-III: Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives,

Module-IV: Design of springs: helical compression, tension, torsional and leaf springs,

Module-V: Design of joints: threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes

Text Books/References:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Sadhu Singh, Machine Design, Khanna Book Publishing Company.
3. Sadhu Singh, Machine Design Data Book, Khanna Book Publishing Company.
4. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
5. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
6. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Design of Machine Elements I	Prof. B. Maiti	IIT KHARAGPUR

Course Outcomes: After the completion of this course, students will get an overview of the design methodologies employed for the design of various machine components.

*****

Course Code	:	MT-602
Course Title	:	Computer Network & Cyber Security
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- To develop an understanding of modern network architectures from a design and performance perspective.
- To introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs).
- To provide an opportModuley to do network programming.
- To provide WLAN measurement ideas.

Course Content:

Module I: Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Module II: Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA

Module III: Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols. Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

Module IV: Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography. Cyber Security Concepts Essential Terminologies: CIA, Risks, Breaches,

Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.

Module V: Cyber Security Vulnerabilities & Safe Guards (8 Hours) Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures.

Text Books/References:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw-Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
3. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
4. Internet working with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
5. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, Moduleed States of America.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Computer Networks & Internet Protocol	Prof. Sandip Chakraborty	IIT Kharagpur

Course Outcomes:

1. To Explain the functions of the different layers of the OSI Protocol.
2. To Draw the functional block diagram of wide-area networks (WANs), Local Area Networks (LANs) and Wireless LANs (WLANs) describe the function of each block.
3. To assess requirement (small scale) of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) design it based on the market available component.
4. To classify problem related TCP/IP protocol developed the network programming.
5. To Configure DNSDDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

*****

Course Code	:	MT-603
Course Title	:	Microprocessor & Microcontroller
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective: To introduce the basics of microprocessors and microcontrollers technology and related applications. Study of the architectural details and programming of 16 bit 8085 microprocessors and its interfacing with various peripheral ICs; Study of architecture and programming of 8085 processors.

Course Content:

Module I: 8085 MICROPROCESSOR: History and Evolution of Microprocessor and their Classification, Architecture of 8085 Microprocessor, Address / Data Bus multiplexing and demultiplexing. Status and Control signal generation, Instruction set of 8085 Microprocessor, Classification of instructions, addressing modes, timing diagram of the instructions.

Module II: Hardware Interfacing with 8085: Methods of data Transfer and Interrupts of 8085 microprocessors: Classification of interrupts, Programming using interrupts, Direct Memory Access, Serial and parallel data transfer, Interfacing of Memory Chips with 8085 Microprocessor, Interfacing of 8085 with 8155/8156 (RAM), 8355/8755 (ROM). Interfacing of Programmable Devices with 8085 Microprocessor, 8279 programmable Keyboard/Display interface, 8255A programmable Parallel interface, 8254 programmable Interval Timer, 8259A programmable Interrupt Controller, Assembly language programming.

Module III: 16-bit low power MCU: Introduction to microcontrollers and embedded systems, Von Neumann (Princeton) and Harvard architecture, RISC and CISC machine, Architecture, Programming Techniques, Addressing Modes, Programming System registers and configuration I/O ports pull up/down registers concepts, Low Power aspects of MSP430: low power modes, Active vs Standby current consumption.

Module IV: Configuring Peripherals in MSP430: External interrupts and software interrupt, interrupt programming, Watchdog timer, Clock Tree in MSP430, Timer/ counter interrupt, Programming MSP430 timer, counter programming, Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition: ADC and Comparator in MSP430, data transfer using DMA.

Module V: Serial Communication Interfaces in MSP430: Basics of serial communication, mode of serial communication, RS232, serial communication issue, Serial port programming. Implementing and programming UART, I2C, SPI interface using MSP430, interfacing external devices, external memory, keyboards, display devices, DAC/ADC, DC Motor, Stepper Motor, Servomotor, power management, Sensor Interfacing and signal conditioning. Case Study: MSP430 based embedded system application using the interface protocols for communication with external devices: "A Low- Power Battery less Wireless Temperature and Humidity Sensor with Passive Low Frequency RFID.

Text Books:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publication (India) Pvt. Ltd.

2. DV Hall, "Microprocessors Interfacing", Tata McGraw Hill Publication.
3. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, "Microprocessors and Microcontrollers", Oxford University Press Publication.
4. Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880
5. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN-13: 978-0750682763

References:

1. http://processors.wiki.ti.com/index.php/MSP430_LaunchPad_Low_Power_Mode.
2. http://processors.wiki.ti.com/index.php/MSP430_16-Bit_Ultra-Low_Power_MCU_Training.
3. AK Roy & KM Bhurchandi, "Advance Microprocessor and Peripherals (Architecture, Programming & Interfacing)", Tata McGraw Hill Publication.

Course Outcomes: The student will be able:

1. To Acquire knowledge about microprocessors and its need.
2. To Write the programs using 8085 and 8086 microprocessors.
3. To illustrate Know the internal architecture and interfacing of different peripheral devices with 8085 and 8086 microprocessors.
4. To Design the system using 8085 processors.

*****

Course Code	:	MT-604
Course Title	:	Manufacturing Technologies
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

1. To provide knowledge on machines and related tools for manufacturing various components.
2. To understand the relationship between process and system in manufacturing domain.
3. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

MODULE I: Patterns and Pattern making, Introduction to Foundry - Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern materials, color coding and storing of patterns Moulding, Moulding methods and processes-materials, equipment, Moulding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making. Design considerations in casting, gating and Riser - directional solidification in castings, Metallurgical aspects of Casting

MODULE II: Casting Processes - Sand castings, pressure die casting, permanent mould casting, centrifugal casting, precision investment casting, shell Moulding, Co2 Moulding, continuous casting-squeeze casting, electro slag casting, Fettling and finishing, defects in Castings, Casting of non-ferrous materials Melting, Pouring and Testing , Melting furnaces- -crucibles oil fired furnaces-electric furnaces-cupola, selection of furnace, calculation of cupola charges-Degasification, inoculation, pouring techniques casting defects and Inspection of castings.

MODULE III: Cutting tools and tool geometry 8 Types of cutting tools, tool materials-HSS (including heat treatment) ceramics, cements, CBN &PCD, tool geometry and nomenclature, selection of tool materials and tool life, tool wear and machinability

Mechanics of clip formation, types of chips and conditions conducive for the formation of each type Built-up edge, its effects Orthogonal Vs oblique cutting- merchant's force circle diagram. Force and velocity relationship, shear plane angle. Energy consideration in Machining-Ernst Merchant theory of shear angle, relationship-original assumptions and modification made.

MODULE IV: Extrusion and Drawing Processes, Classification of extrusion processes-tool, equipment, and principle of these processes, influence on Friction-Extrusion force calculation-defects and analysis-rod/wire drawing-tool, equipment and principle of processes.

Powder Metallurgy Introduction to Powder Metallurgy process, preparation of powders, types & function of binders, green compaction, sintering process and its effect on the product, application of powder metallurgy products, advantages of powder metallurgy products. Sintering equipment.

MODULE V: Basic Joining Processes Types of welding-gas welding, -arc welding, -shielded metal arc welding, GTAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-atomic hydrogen arc welding-thermit welding, Flame cutting - Use of Oxyacetylene, modern cutting processes, arc cutting.

Soldering, brazing and braze welding and their application., welding of special materials –Stainless steel, aluminium etc. weldability of cast iron, steel, stainless steel, aluminium alloys. Introduction to Electron beam and Laser welding.

Text Books/References:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Kalpakjian and Schmid, Manufacturing Engineering and Technology, 6 ed., Pearson.
3. Lindberg, Processes & Materials of Manufacture, Prentice Hall India.
4. Kumar & Gupta, Manufacturing Processes, Prentice Hall India.

5. Jain, Production Technology, Khanna Publications.
6. Rao, Manufacturing Processes, McGraw Hill Education.
7. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India,2003.
8. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Manufacturing Processes I	Dr. Pradeep Kumar	IIT ROORKEE

Course Outcomes: Upon completion of this course, students will be able to the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components and the application of optimization methods in manufacturing.

*****

Course Code	:	MTPE-60X
Course Title	:	Professional Elective I
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MTPE

Any one course from following may be opted as "Professional Elective I":
1. Optimization Technique (MTPE-601)
2. Operation Research (MTPE-602)
3. Total Quality Management (MTPE-603)

Refer Appendix I on Professional Electives.

*****

Course Code	:	MT-611
Course Title	:	Computer Aided Design Lab
Number of Credits	:	2 (L: 0; T: 0; P: 4)
Course Category	:	MT

Course Objective:

- To impart fundamental knowledge to students in the latest technological topics on Computer Aided Design, Computer Aided Manufacturing and Computer Aided Engineering Analysis and to prepare them for taking up further research in the areas.

- To create a congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations.
- To broaden and deepen their capabilities in analytical and experimental research methods, analysis of data, and drawing relevant conclusions for scholarly writing and presentation.
- To provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.

List of Experiments:

1. Geometric Transformation algorithm experiment for translation/rotation/scaling: Writing and validation of computer programs.
2. Design of machine components or other system experiments: Writing and validation of computer programs.
3. Understanding and use of any 3-D Modeling Software / commands.
4. Experiment: Solid modeling of a machine component using CAD Software.
5. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package
6. Numerical differentiation or numerical integration experiment: Writing and validation of computer programs.

Text Books/References:

1. Basu, S. K. and Pal, D.K., Design of Machine Tools, Allied Publishers (2008).
2. Acherkhan, N.S., Machine Tool Design, University Press of the Pacific, (2000).
3. Boothroyd G and Knight Wiston A., Fundamentals of Machining and Machine Tools, CRC Press (2005).
4. Sharma, P. C., A Text Book of Machine Tools & Tool Design, S. Chand Limited, (2005).

Course Outcomes: Upon completion of this course, students will be able: -

1. To develop solutions in the areas of Design and simulation in Mechanical Engineering.
2. To develop Have abilities and capabilities in applying computer software and hardware to mechanical design and manufacturing fields.
3. To Review and document the knowledge developed by scholarly predecessors and critically assess the relevant technological issues.
4. To Formulate relevant research problems; conduct experimental and/or analytical study and analyzing results with modern mathematical / scientific methods and use of software tools.
5. To Design and validate technological solutions to defined problems and communicate clearly and effectively for the practical application of their work.

*****

Course Code	:	MT-612
Course Title	:	Computer Network & Cyber Security Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: In this course, students will learn the fundamental principles of computer and network security by studying attacks on computer systems, network, and the Web. Students will learn how those attacks work and how to prevent and detect them. The course emphasizes "learning by doing", and requires students to conduct a series of lab exercises. Through these labs, students can enhance their understanding of the principles, and be able to apply those principles to solve real problems. After completion of the course, students should be able to possess the following skills:

- be able to explain security principles,
- be able to evaluate risks faced by computer systems,
- be able to explain how various attacks work,
- be able to describe and generalize various software vulnerabilities

List of Experiments:

1. Study of different wireless network components and features of any one of the Mobile Security Apps.
2. Study of the features of firewall in providing network security and to set Firewall Security in windows.
3. Steps to ensure Security of any one web browser (Mozilla Firefox/Google Chrome)
4. Study of different types of vulnerabilities for hacking websites / Web Applications.
5. Analysis the Security Vulnerabilities of E-commerce services.
6. Analysis the security vulnerabilities of E-Mail Application

Text Books/References:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw-Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
3. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.

Course Outcomes:

- To understand the basics of Computer Networks, Cyber Security and Various Protocols. He / She will be in a position to understand the World Wide Web concepts.
- To illustrate a network and flow of information further he/she can understand easily the concepts of network security, Mobile and ad hoc networks.

*****

Course Code	:	MT-613
Course Title	:	Microprocessor & Microcontroller Lab
Number of Credits	:	2 (L: 0; T: 0; P: 4)
Course Category	:	MT

Course Objective:

- To expose students to the operation of a typical microprocessor (8085) trainer kit.
- To prepare the students to be able to solve different problems by developing different programs.
- To develop the quality of assessing and analyzing the obtained data.

List of Experiments:

8086 Programs using kits and MASM

1. Basic arithmetic and Logical operations
2. Move a data block without overlap
3. Code conversion, decimal arithmetic and Matrix operations.
4. Floating point operations, string manipulations, sorting and searching
5. Password checking, Print RAM size and system date
6. Counters and Time Delay

Peripherals and Interfacing Experiments using 8085 and 16 bit MCU.

1. Traffic light control.
2. Stepper motor control.
3. Digital clock 10. Keyboard and Display.
4. Printer status 12. Serial interface and Parallel interface.
5. A/D and D/A interface and Waveform Generation.

Text Books/References:

1. A K Ray and K M Bhurchandi, “Advanced Microprocessors & Peripherals”, 2nd ed., TMH, 2006.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, “The 8051 microcontroller and embedded systems”, Pearson education, 2004.

Course Outcomes: At the end of the course, the students will be able

1. To Identify relevant information to supplement the Microprocessor and Microcontroller course.
2. To Set up programming strategies and select proper mnemonics and run their program on the training boards.
3. To Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.
4. To Develop testing and experimental procedures on Microprocessor and Microcontroller analyze their operation under different cases.

*****

Course Code	:	MT-614
Course Title	:	Manufacturing Technologies Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective: To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

List of Experiments:

1. Design of pattern & pattern making: At least one wooden pattern with proper calculations.
2. Making a green sand mould
   - One mould each on pit Moulding & split pattern.
   - At least two for different type of components with core and without core to be made.
3. Sand testing experiments to determine:
   - Grain Fineness Number
   - Green Strength
   - Permeability Test
   - Moisture content test

4. Study, understanding and working of simple destructive & non-destructive testing procedures used for castings.

5. Measurement of forces for orthogonal turning operation by tool dynamometer.

6. Visit to foundry – study of automation processes, Layout, Material handling equipment & other processes with preparation of report.

7. Study of the extrusion and drawing process – visit to industry with report presentation.

8. Welding Lab:

   - Preparation of simple shapes of metal sheets by gas cutting.
   - Preparation of specimen & welding of: Angle joint / T joint Lap joint / Butt joint (use of both Arc & Gas welding).
   - Study, understanding and working of simple destructive & non-destructive testing procedures used for welding.
   - Study on influence of welding parameters in Arc & Gas welding with demonstration.

9. Study of the extrusion and drawing process – visit to industry with report presentation.

Text Books/References:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Taha H. A., Operations Research, 6thEdition, Prentice Hall of India,2003.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Manufacturing of simple sheet metal components using shearing and bending operations.	http://msvs-dei.vlabs.ac.in/msvs-dei/SheetMetal.php

Course Outcomes: Upon the completion of this course the students will be able

1. To Demonstrate the safety precautions exercised in the mechanical workshop.
2. To contrast workpiece as per given shape and size using Lathe.
3. To illustrate Join two metals using arc welding.
4. To demonstrate Use sheet metal fabrication tools and make a simple tray and funnel.
5. To design Use different moulding tools, patterns and prepare sand moulds.

*****

Course Code	:	MT-615
Course Title	:	Seminar
Number of Credits	:	1
Course Category	:	MT

The objective of the seminar is to improve communication/presentation skills of students and develop his/her acquaintance with new and upcoming technologies including new and emerging processes. Faculty in-charge may select the appropriate topic for the student and fixup the time and duration of the presentation. Students are expected to improve their awareness of careers and their individual career goals through this activity.

*****

SEMESTER – VII

SEMESTER VII

Course Code	:	MT-701
Course Title	:	Robotics
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

- To acquire the knowledge on advanced algebraic tools for the description of motion.
- To develop the ability to analyze and design the motion for articulated systems.
- To develop an ability to use software tools for analysis and design of robotic systems.

Course Contents:

Module I: Introduction:
Definition, Classification of Robot – Industrial Robot & Service Robot, Anatomy, Spatial coordinates, Geometric configurations and work envelope, Machine intelligence, Criteria for robot selection, Safety standards for Industrial Robot, Economic justification, Robot Applications-Material handling, Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Medical Industry, Future of Robotics.

Module II: Robot Programming:
Introduction, On-line programming: Manual input, Lead through -programming, Teach pendant programming, Off-line programming language, Simulation, Introduction to ROS Concept

Module-III: Kinematics of Robotic Manipulators:
Introduction to manipulator kinematics, Homogeneous transformations and robot kinematics, Denavit- Hartenberg (D-H) representation, Concept of forward and inverse kinematics.

Module-IV: Control of Robot Manipulator:
Open and closed loop control system, Control system concepts, Linear control schemes, PID control system, Types of motion control, drives and control, Planning of trajectories, Human Robot Collaboration

Module V: Control Components and Sensors:
Mechanical control by stops and cams, Solenoids, Relays; Internal Sensors, potentiometers, resolvers and encoders; External sensing: Simple touch sensing, strain sensing, tactile sensing, acoustic sensing, magnetic sensing, capacitive sensing, laser sensing & machine vision

Text Books/References:

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985.

3. J.J. Craig, Robotics, Addison-Wesley, 1986.
4. Saeed B. Niku, "Introduction to Robotics – Analysis, Systems and Application" : PHI 2006.
5. Richard D, Klafter, Thomason A ChmielOwski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005.
6. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007.
7. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
8. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Robotics	Prof. Dilip Kumar Pratihar	IIT Kharagpur
2.	Robotics	PROF. D.K. PRATIHAR	IIT Kharagpur

Course Outcomes:

1. To Understand the basic knowledge on robotics.
2. To demonstrate the different type of robot programing & distinguish between them
3. To Design various types of linkage mechanism for obtaining specific motion and analyze them for optimal functioning.
4. To inspect the knowledge related to control techniques related to robot systems.
5. To Understand the knowledge of different types of sensor used in robot systems.

*****

Course Code	:	MT-702
Course Title	:	Mechatronics System
Number of Credits	:	3 (L: 2; T: 1; P: 0)
Course Category	:	MT

Course Objective: This course aims at providing fundamental understanding about the elements of a mechatronics system, interfacing, and its practical applications.

Course Contents:

Module I: Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modelling, Analysis and Simulation, Man-Machine Interface;

Module II: Sensors and transducers: classification, Development in Transducer technology, Opto-Electronics-Shaft encoders, CD Sensors, Vision System, etc.;

Module III: Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;

Module IV: Replacement Programmable Logic Controllers: Basic Structure, Types and Working Principle, Concept of Scan Cycle and Scan Time, IO's and its Types, Selection Criteria and Applications
Programming Techniques: Ladder diagram –Concept of Contacts and Coil, Latching/ Holding Circuit, Memory Bits, Timers and Counter.

Module V: Micro mechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

Text Books/References:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.).
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education.
3. A Textbook of Mechatronics, R.K.Rajput, S. Chand & Company Private Limited.
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Mechatronics & Manufacturing Automation	Dr. Shrikrishna N. Joshi	IIT Guwahati

Course Outcomes: Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

*****

Course Code	:	MT-703
Course Title	:	Computer Aided Manufacturing
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Course Objective:

1. To educate students by covering different aspects of computer Aided Manufacturing.
2. To create strong skills of writing CNC programs, PLC programs.
3. To educate students to understand different advances in manufacturing systems like: GT, CAPP and FMS.

4. To educate students by covering different integrated production management systems.

Course Content:

Module I: Fundamentals of Numerical Control, elements of NC machine tools, classification of NC machine tools, Advantages, suitability and limitations of NC machine tools, Application of NC system.
Definition and designation of control axes, Constructional details of Numerical Control Machine Tools, MCU structure and functions, Methods of improving accuracy and productivity using NC.

Module II: Computer Numerical Control (CNC): Features of CNC, Elements of CNC machines, the machine control Module for CNC, Direct Numerical Control(DNC) and Adaptive Controls.
System Devices: Drives, Feedback devices, counting devices, DAC and ADCs, Interpolator systems, Control loop circuit elements in PTP system, Contouring system, Incremental and absolute systems.

Module III: NC Part Programming- (a) Manual (word address format) programming Examples Drilling, Turning and Milling; canned cycles, Subroutine, and Macro.
Computer Assisted Part programming (APT) Geometry, Motion and Additional statements, Macro- statement.

Module IV: Computer Integrated manufacturing system, Group Technology, Flexible Manufacturing System, Computer aided process Planning-Retrieval and Generative System. Manufacturing Execution System; Overview, Components and Functionality, Relationship between MES and ERP, Benefits of MES.

Module V: Smart Manufacturing; Introduction to additive manufacturing, IoT, Smart Sensing, Smart Machines, Data Visualization and Analysis, Augmented Reality, Automated material handling & Cobots. Overview of 3D printing Technology, Materials used in 3D printing, Cyber-security for manufacturing.

Text Books/References:

1. Automation, Production System and Computer Integrated Manufacturing, by Mikell P. Grover, Prentice Hall of India Pvt Ltd.
2. CAD/CAM – Theory and Practice, by Ibrahim Zeid, McGraw Hill.
3. Computer Aided Manufacturing, by Cheng, Pearson India.
4. CAD/CAM: Principles and Operations, by P. N. Rao, McGraw Hill.
5. CAD/CAM: Computer Aided Design and Manufacturing, by M. Groover, Pearson India. CAD/CAM: Concepts and Applications by Alavala, PHI India.
6. Computer Aided Manufacturing, by Srinivas, Oxford University Press.

Course Outcomes: After learning the course:

1. To describe basic concepts of CAM application and understand CAM wheel.
2. To design CNC programs for manufacturing of different geometries on milling and lathe machines.
3. To illustrate logic diagrams for different applications of automation.
4. To classify different components using different techniques of group technology.
5. To develop process planning for different components.

*****

Course Code	:	MT-70X
Course Title	:	Professional Elective II
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MT

Any one course from following options can be opted under 'Professional Elective II':

1. Product Development (MTPE-701)
2. Rapid Prototyping (MTPE-702)
3. Machine Learning (MTPE-703)

Refer Appendix I on Professional Electives.

*****

Course Code	:	MT-711
Course Title	:	Robotics Lab
Number of Credits	:	2 (L: 0; T: 0; P: 4)
Course Category	:	MT

Course Objective:

1. To introduce different types of robotics and demonstrate them to identify different parts and components.
2. To write programming for simple operations.

List of Experiments:

1. Study the major equipment/Software/Components in Robotics Lab, e.g. Robotic Arm components, Arena etc.
2. Study components of a real robot and its DH parameters.
3. Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro controllers and ROS (Robot Operating System) in a robotic system

Exercise on any Robotic Simulation Software

1. Determination of maximum and minimum position of links.
2. Study Forward kinematics and validation.
3. Study Inverse kinematics o and validation.
4. Measure the knowledge of Robotic arm, material handling, Scorbase Software and Homing and Moving Robot
5. Recoding Robot positions (Absolute positions, Delete Positions, Save and load positions and Move the Robot to recorded positions.)
6. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system.
7. Robot Programming and Simulation using linear and nonlinear paths.
8. Writing and running Robot programs – Activity material handling operation.
9. Estimation of accuracy, repeatability and resolution.
10. Make a model using software to simulate the processing in small manufacturing cell.
11. Study and Simulate path planning and navigation in ROS.
12. Study the implementation of PID Control in ROS.

Text Books/References:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Richard D, Klafter, Thomason A ChmielOwski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005.
3. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. No.	Experiment Name	Experiment Link(s)
1	Study components of a real robot and its DH parameters.	http://vlabs.iitkgp.ernet.in/mr/exp2/index.html

Course Outcomes: Upon Completion of the course, the students will be able;

1. To assess kinematics & dynamic analysis of robot manipulators.
2. To understand the functionality and limitations of robot actuators.
3. To program a robot to perform a specified task in a target environment and solve problems in areas such as robot control and navigation.
4. To Understand how simulations of robots, where they can be useful and where they can break down.

*****

Course Code	:	MT-712
Course Title	:	Computer Aided Manufacturing Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	MT

Course Objective:

1. Acquire fundamental understanding of the principles of CAD/CAM, including engineering drawing, geometric and surface and feature-based design.
2. Math behind geometry to understand CAD.
3. Applying CAD/CAM concept to product design and manufacturing.
4. Exposure to CAD/CAM software's.
5. Exposure to machines at Imagineering lab.

List of Experiments:

1. Study of CNC VMC part programming fundamentals and writing part program.
2. Study and demonstration of CNC VMC.
3. Part Programming (in word address format) experiment for turning operation (including operations such as grooving and threading) and running on CNC machine.
4. Part Programming (in word address format or ATP) experiment for drilling operation (point to point) and running on CNC machine.
5. Part Programming (in word address format or ATP) experiment for milling operation (contouring) and running on CNC machine.
6. Experiment on difference between ordinary machine and NC machine, study or retrofitting.

Text Books/References:

1. Chang, T. C., Wysk, R. A., Wang, H. P, "Computer aided Manufacturing," Prentice Hall, Third Ed.,
2. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing, "John Wiley and Sons Ltd, First Ed.

Course Outcomes: The student will be able:

1. To Understand engineering design concepts.
2. To illustrate Product specification methods.
3. To Construct 3D part models.
4. To examine Geometric tolerance.
5. To Understand process planning.
6. To design Rapid Manufacturing.

*****

Course Code	:	MT-713
Course Title	:	Project Work I
Number of Credits	:	2 (L: 0; T: 0; P: 4)
Course Category	:	MT

The objective of Project Work-I is to enable the student to take up investigative study in the broad field of Mechatronics Engineering, either fully theoretical/practical or involving both. Theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment normally includes:

- Survey and study of published literature on the assigned topic;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Conducting preliminary Analysis / Modeling / Simulation / Experiment / Design / Feasibility;
- Preparing a Written Report on the Study conducted for presentation to the Department;
- Final Seminar, as oral Presentation before a Departmental Committee.

*****

Course Code	:	MT-714
Course Title	:	Mini Project or Internship.
Number of Credits	:	1
Course Category	:	MT

Mini Project or Internship of 3 to 4 Weeks shall be performed during summer break after semester VI and this will be assessed as part of Semester VII.

During the summer vacations, after the 6th Semester, students are required to be involved in Inter/ Intra Institution Activities viz.; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institution; contribution at incubation/ innovation /entrepreneurship cell of the Institution; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovations Council for e.g.: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

After completion of Mini-project or Internship the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period or while working on mini-project. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics.

Student's Diary and Internship Report should be submitted by the students along with an attendance record and an evolution sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawing, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

*****

SEMESTER – VIII

SEMESTER VIII

Course Code	:	MTOE-80X
Course Title	:	Open Elective I
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MTOE

Any one course from following options can be opted under 'Open Elective I':

1. Virtual and Augmented Reality (MTOE-801)
2. Image Processing & Computer Vision (MTOE-802)
3. Wireless Network & Communication (MTOE-803)

For syllabus, Refer Appendix II on Open Electives.

*****

Course Code	:	MTOE-80X
Course Title	:	Open Elective II
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	MTOE

Any one course from following options can be opted under 'Open Elective II':

1. Artificial Intelligence (MTOE-804)
2. Real Time System (MTOE-805)
3. Artificial Neural Network (MTOE-806)

For syllabus, Refer Appendix II on Open Electives.

*****

Course Code	:	MT-811
Course Title	:	Project Work II
Number of Credits	:	10
Course Category	:	MT

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under EC P1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the

Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under EC P1;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department;
8. Final Seminar Presentation before a Departmental Committee.

*****

Appendix – I

Professional Electives

Professional Elective I

List of available courses under Professional Elective – I (L: 3, T: 0, P: 0)		
S. No.	**Subject Code**	**Subject**
1	MTPE-601	Optimization Techniques
2	MTPE-602	Operation Research
3	MTPE-603	Total Quality Management

Professional Elective II

List of available courses under Professional Elective – II (L: 3, T: 0, P: 0)		
S. No.	**Subject Code**	**Subject**
1	MTPE-701	Product Development
2	MTPE-702	Rapid Prototyping
3	MTPE-703	Machine Learning

Professional Elective I

S. No.	Subject Code	Subject
1	MTPE-601	Optimization Techniques
2	MTPE-602	Operation Research
3	MTPE-603	Total Quality Management

Course Code	:	MTPE-601
Course Title	:	Optimization Techniques
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTPE

Course Objective: The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear programming problem, Integer programming problem, Transportation problem, two person zero sum games with economic applications and project management techniques using PERT and CPM.

Course Content:

Module I: Scope of Operations Research: Introduction to linear and non-linear programming formulation of different models.

Module II: Linear Programming: Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity analysis.

Integer Programming: Branch and bound technique.

Module III: Transportation and Assignment Problem: Initial basic feasible solutions of balanced and unbalanced transportation/assignment problems, optimal solutions.

Module IV: Project Management**:** Construction of networks, Network computations, Floats (free floats and total floats), Critical path method (CPM), Crashing.

Module V: Game Theory**:** Two persons zero-sum game, Game with mixed strategies, Graphical method and solution by linear programming.

Text/ References Books:

1. Chandra, S., Jayadeva.,Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013).
2. Taha H.A., Operations Research-An Introduction, PHI (2007).

3. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004)
4. BazaarraM.S., Jarvis J.J., and ShiraliH.D., Linear Programming and Network flows, John Wiley and Sons (1990)
5. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons,

Course Outcomes: Upon Completion of this course the students will be able:

1. To Formulate and solve linear programming problems.
2. To solve the transportation and assignment problems

*****

Course Code	:	MTPE-602
Course Title	:	Operations Research
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTPE

Course Objective: This course aims at familiarizing the students with quantitative tools and techniques, which are frequently applied to business decision-making & to provide a formal quantitative approach to problem solving and an intuition about situations where such an approach is appropriate.

Course Content:

MODULE I: Introduction to Operations research- Scope, applications of operations research, phases and models of operations research, advantages and limitations of operations research. Linear programming problem (LPP)- formulation of linear programming problem (LPP), graphical method of solution, simplex method, artificial variable technique- Big M method and two phase method, duality in LPP, sensitivity analysis.

MODULE II: Transportation Problem (TP)-Mathematical formulation of TP, methods to obtain initial basic feasible solution, TP without degeneracy and TP with degeneracy. Assignment Problem (AP) - Mathematical formulation of AP, comparison with TP, variations of AP, Traveling salesman problem. Sequencing Problem- Assumptions in sequencing problem, processing of n jobs through two machines, processing of n jobs through three machines, and processing of n jobs through m machines.

MODULE III: Replacement models- Introduction, replacement of items that detoriates- replacement of items whose maintenance and repair cost increases with time, ignoring money value and - replacement of items whose maintenance and repair cost increases with time, considering money value, replacement of items that fail suddenly- group replacement.

Queuing model- Kendall's notation for representing queuing models, single channel Poisson arrivals with exponential service times, infinite population.

MODULE IV: Games theory- Minimax (Maximin) criterion for optimality, characteristics of games, dominance principles, 2X2 game arithmetic and algebraic method, 2Xn and mX2 game-graphical method and method of subgames, 3X3 game- method of matrices, iteration method and applications of games theory.

MODULE V: Inventory models- Need and types of inventory, inventory associated costs, Economic order quantity, Classical EOQ inventory model with uniform demand rate and infinite replenishment. EOQ model with multiple price breaks. Simulation- Monte Carlo simulation, advantages and limitations of simulation, applications of simulations.

MODULE VI: Network analysis- Network construction, identification of critical path, various types of floats and their computations, Programme Evaluation and Review Technique (PERT) time calculations, crashing of network, resource scheduling, network updating.

Text Books:

1. Operations Research: S. D. Sharma, Kedar Nath Ram Nath, Meerut.
2. Operations Research: P. K. Gupta, Sultan, Chand & Sons.

References:

1. Operations Research-An Introduction: Hamdy A Taha, Pearson Eduction.
2. Operations Research: Methods and Problems, Maurice Saseini, ArhurYaspan and Lawrence Friedman.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Fundamentals of Operations Research	Prof. G. Srinivasan	IIT Madras

Course Outcomes: After completion of this course, the students will be able

1. To Illustrate the need to optimally utilize the resources in various types of industries.
2. To Apply and analyze mathematical optimization techniques to various applications.
3. To Demonstrate cost effective strategies in various applications in industry.

*****

Course Code	:	MTPE-603
Course Title	:	Total Quality Management
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTPE

Course Objective: To learn about

1. Total customer satisfaction
2. Totality of functions
3. Total range of products and services
4. Addressing all aspects of dimensions of quality
5. Addressing the quality aspect in everything – products, services, processes, people, resources and interactions.
6. Satisfying all customers – internal as well as external
7. Addressing the total organizational issue of retaining customers and
8. Improving profits, as well as generating new business for the future.
9. Involving everyone in the organization in the attainment of the said objective.
10. Demanding total commitment from all in the organization towards the achievement of the objective

Course Content:

MODULE I: Introduction to Quality Management

Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.

MODULE II: Principles and Philosophies of Quality Management

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology.

MODULE III: Statistical Process Control and Process Capability

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed.

Process capability – meaning, significance and measurement – Six sigma concepts of process capability.

Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve. Total productive maintenance (TMP) – relevance to TQM, Terotechnology. Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

MODULE IV: Tools and Techniques for Quality Management

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation. Seven old (statistical) tools. Seven new management tools. Bench marking and POKA YOKE.

MODULE V: Quality Systems Organizing and Implementation

Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Introduction to software quality.

Text Books:

1. Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004).
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.
3. Sharma S.C. & Poonia M.P., Total Quality Management, Khanna Book Publishing, 2018.

Course Outcomes: After completion of this course, the students will be able

1. To Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.
2. To Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
3. To Critically appraise the organizational, communication and teamwork requirements for effective quality management.
4. To Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans.

*****

Professional Elective II

S. No.	Subject Code	Subject
1	MTPE-701	Product Development
2	MTPE-702	Rapid Prototyping
3	MTPE-703	Machine Learning

Course Code	:	MTPE-701
Course Title	:	Product Development
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTPE

Course Objective: This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

Course Content:

MODULE I: Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products – establishing markets- market segments- relevance of market research.

MODULE II: Identifying customer needs –voice of customer –customer populations-hierarchy of human needs gathering methods – affinity diagrams – needs importance-establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies.

MODULE III: Creative thinking –creativity and problem solving- creative thinking methods-generating design concepts-systematic methods for designing –functional decomposition – physical decomposition – functional representation –morphological methods-TRIZ-axiomatic design.

MODULE IV: Decision making –decision theory –utility theory –decision trees –concept evaluation methods – Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture.

MODULE V: Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation – categories of cost –overhead costs – activity based costing –methods of developing cost estimates – manufacturing cost –value analysis in costing**.**

Text Books/References:

1. George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9.
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
3. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education, ISBN 9788177588217.
4. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.
5. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.

Course Outcomes: After completion of this course, the students will be able

1. To analyze the product design and development processes in manufacturing industry.
2. To understand the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.
3. To evaluate the methodologies for product design, development and management.
4. To illustrate product development to satisfy customer needs.
5. To Carry out cost and benefit analysis through various cost models.
6. To outline design protection and Intellectual Property.

*****

Course Code	:	MTPE-702
Course Title	:	Rapid Prototyping
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTPE

Course Objective: Generating a good understanding of RP history, its development and applications. To expose the students to different types of Rapid prototyping processes, materials used in RP systems and reverse engineering.

Course Content:

MODULE I: Introduction

History – Development of RP systems – Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing- Principle – Fundamental – File format –

Other translators – medical applications of RP – On demand manufacturing – Direct material deposition – Shape Deposition Manufacturing.

MODULE II: Liquid Based and Solid Based Rapid Prototyping Systems

Classification – Liquid based system – Stereo Lithography Apparatus (SLA), details of SL process, products, Advantages, Limitations, Applications and Uses. Solid based system – Fused Deposition Modelling, principle, process, products, advantages, applications and uses – Laminated Object Manufacturing

MODULE III: Powder Based Rapid Prototyping Systems

Selective Laser Sintering – principles of SLS process, principle of sinter bonding process, Laser sintering materials, products, advantages, limitations, applications and uses. Three Dimensional Printing – process, major applications, research and development. Direct shell production casting – key strengths, process, applications and uses, case studies, research and development. Laser Sintering System, e-manufacturing using Laser sintering, customized plastic parts, customized metal parts, e-manufacturing – Laser Engineered Net Shaping (LENS).

Text Books:

1. Rafiq I. Noorani, Rapid Prototyping, "Principles and Applications", Wiley & Sons, 2006.
2. Chua C.K, Leong K.F and Lim C.S, "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific, 2003.

References:

1. N.Hopkinson, R.J.M, Hauge, P M, Dickens, "Rapid Manufacturing – An Industrial revolution for the digital age", Wiley, 2006
2. Ian Gibson, "Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototying", Wiley, 2006
3. Paul F.Jacobs, "Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography", McGraw Hill 1993.
4. Pham. D.T., and Dimov. S.S., "Rapid Manufacturing", Springer Verlog 2001.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Rapid Manufacturing	Prof. Janakranjan Ramkumar	IIT Kanpur

Course Outcomes: At the end of course, student will have knowledge on different types of Rapid Prototyping systems and its applications in various fields.

*****

Course Code	:	MTPE-703
Course Title	:	Machine Learning
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTPE

Course Objective:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To have a thorough understanding of the Supervised and Unsupervised learning techniques.
3. To study the various probability based learning techniques
4. To understand graphical models of machine learning algorithms

Course Contents:

MODULE I: Introduction

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

MODULE II: Linear Models

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

MODULE III: Tree and Probabilistic Models

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

MODULE IV: Dimensionality Reduction and Evolutionary Models

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic

Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process.

MODULE V: Graphical Models

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

Text Books:

1. Stephen Marsland, —Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, —Machine Learning‖, First Edition, McGraw Hill Education, 2013.
3. Jeeva Jose, - Introduction to Machine Learning‖, First Edition, Khanna Publishing House.

References:

4. Peter Flach, —Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.
5. Jason Bell, —Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014.
6. Ethem Alpaydin, —Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series) ‖, Third Edition, MIT Press, 2014.
7. Rajiv Chopra, - Machine Learning‖, Second Edition, Khanna Book Publishing.

Course Outcomes: Upon completion of the course, the students will be able:

1. To Distinguish between, supervised, unsupervised and semi-supervised learning
2. To Apply the apt machine learning strategy for any given problem
3. To classify supervised, unsupervised or semi-supervised learning algorithms for any given problem.
4. To Design systems that uses the appropriate graph models of machine learning.
5. To Modify existing machine learning algorithms to improve classification efficiency.

*****

Appendix – II

Open Electives

Open Elective I

List of available courses under Open Subject – I (L: 3, T: 0, P: 0)		
S. No.	**Subject Code**	**Subject**
1	MTOE-801	Virtual and Augmented Reality
2	MTOE-802	Image Processing and Computer Vision
3	MTOE-803	Wireless Network & Communication

Open Elective II

List of available courses under Open Subject – II (L: 3, T: 0, P: 0)		
S. No.	**Subject Code**	**Subject**
1	MTOE-804	Artificial Intelligence
2	MTOE-805	Real Time System
3	MTOE-806	Artificial Neural Network

Open Elective I

S. No.	Subject Code	Subject
1	MTOE-801	Virtual and Augmented Reality
2	MTOE-802	Image Processing and Computer Vision
3	MTOE-803	Wireless Network & Communication

Course Code	:	MTOE-801
Course Title	:	Virtual and Augmented Reality
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTOE

Course Objective: To understand the basic concepts of Augmented and Virtual Reality. The student must be able to apply the various concepts of Augmented and Virtual Reality in other application areas.

Course Content:

Introduction of Virtual Reality: Fundamental concept and components of Virtual Reality, primary features and present development on Virtual Reality.

Multiple Models of Input and Output Interface in Virtual Reality: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices.

Visual Computation in Virtual Reality: Fundamentals of computer graphics, software and hardware technology on stereoscopic display, advanced techniques in CG: Management of large scale environments & real time rendering.

Environment Modelling in Virtual Reality: Geometric Modelling, Behavior Simulation, Physically Based Simulation.

Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Menus, Object Grasp.

Introduction of Augmented Reality (AR): System structure of Augmented Reality, key technology in AR.

Development Tools and Frameworks in Virtual Reality: Frameworks of software development tools in VR, X3D Standard, Vega, MultiGen, Virtools etc.
Mixed Reality: Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection

interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Application of VR in Digital Entertainment: VR technology in film & TV production, VR technology in physical exercises and games, demonstration of digital entertainment by VR.

Laboratory Work: To implement various techniques studied during the course.

Text Books:

1. Doug A. B., Kruijff E., LaViola J. J. and Poupyrev I., 3D User Interfaces: Theory and Practice, Addison-Wesley (2005,2011p) 2nd ed.
2. Parisi T., Learning Virtual Reality, O'Reilly (2016) 1st ed.
3. Schmalstieg D. and Hollerer T., Augmented and Virtual Reality, Addison-Wesley (2016).

References:

1. Whyte J., Virtual Reality and the Built Environment, Architectural Press (2002).
2. Aukstakalnis S., Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley (2016)

Course Outcomes: After the completion of the course, the student will be able:

1. To Analyze the components of AR and VR systems, its current and upcoming trends, types, platforms, and devices.
2. To Assess technologies in the context of AR and VR systems design.
3. To Implement various techniques and algorithms used to solve complex computing problems in AR and VR systems.
4. To Develop interactive augmented reality applications for PC and Mobile based devices using a variety of input devices.
5. To Demonstrate the knowledge of the research literature in augmented reality for both compositing and interactive applications.

*****

Course Code	:	MTOE-802
Course Title	:	Image Processing and Computer Vision
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTOE

Course Objective:

1. To review image processing techniques for computer vision.
2. To understand shape and region analysis.
3. To understand Hough Transform and its applications to detect lines, circles, ellipses.
4. To understand three-dimensional image analysis techniques.

5. To understand motion analysis.
6. To study some applications of computer vision algorithms.

Course Content:

MODULE I: IMAGE PROCESSING FOUNDATIONS

Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology – texture.

MODULE II: SHAPES AND REGIONS

Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moments.

MODULE III: HOUGH TRANSFORM

Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation.

MODULE IV: 3D VISION AND MOTION

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion

MODULE V: APPLICATIONS

Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.

Text Books/References:

1. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012.
2. R. Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011.
3. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012.
4. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
5. D. L. Baggio et al., "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012.
6. Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images", O'Reilly Media, 2012.

Course Outcomes: Upon completion of the course, the students will be able:

1. To Implement fundamental image processing techniques required for computer vision.
2. To design shape analysis.
3. To Implement boundary tracking techniques.
4. To Apply chain codes and other region descriptors.
5. To Apply Hough Transform for line, circle, and ellipse detections.
6. To Apply 3D vision techniques.
7. To Implement motion related techniques.
8. To Develop applications using computer vision techniques.

*****

Course Code	:	MTOE-803
Course Title	:	Wireless Network and Communication
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTOE

Course Objective:

- To study about Wireless networks, protocol stack and standards.
- To study about fundamentals of 3G Services, its protocols and applications.
- To study about evolution of 4G Networks, its architecture and applications.

Course Content:

MODULE I: WIRELESS LAN: Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security – IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX.

MODULE II: MOBILE NETWORK LAYER: Introduction – Mobile IP: IP packet delivery, Agent discovery, tunnelling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol – mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing.

MODULE III: MOBILE TRANSPORT LAYER: TCP enhancements for wireless protocols – Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility – Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP – TCP over 3G wireless networks.

Text Books:

1. Jochen Schiller," Mobile Communications", Second Edition, Pearson Education 2012. (Module I, II, III).
2. Vijay Garg, "Wireless Communications and networking", First Edition, Elsevier 2007. (Module IV, V).

Reference Books:

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.
2. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", First Edition, Elsevier 2011.
3. Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013.

Course Outcomes: Upon completion of the course, the students will be able

- To explain 3G/4G and WiMAX networks and its architecture.
- To Design and implement wireless network environment for any application using latest wireless protocols and standards.
- To Implement different type of applications for smart phones and mobile devices with latest network strategies.

*****

Open Elective II

S. No.	Subject Code	Subject
1	MTOE-804	Artificial Intelligence
2	MTOE-805	Real Time System
3	MTOE-806	Artificial Neural Network

Course Code	:	MTOE-804
Course Title	:	Artificial Intelligence
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTOE

Course Objective: The student should be made to:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.

Course Content:

MODULE I: Introduction to Al and Production Systems

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized productions system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

MODULE II: Representation of Knowledge

Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other Logic-Structured representation of knowledge.

MODULE III: Knowledge Inference

Knowledge representation -Production based system, Frame based system. Inference – Backward chaining, forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

MODULE IV: Planning and Machine Learning

Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.

MODULE V: Expert Systems

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Text Books:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008. (Modules-I, II, VI & V)
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. (Module-III).

References:

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. M.C. Trivedi, "A Classical Approach to Artificial Intelligence", Khanna Book Publishing, 2018.
3. Stuart Russel and PeterB Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
4. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.
5. http://nptel.ac.in

Course Outcomes: At the end of the course, the student should be able:

- To Identify problems that are amenable to solution by AI methods.
- To identify AI methods to solve a given problem.
- To illustrate problem in the language/framework of different AI methods.
- To Implement basic AI algorithms.
- To Design and carry out an empirical evaluation of different algorithms on a problem formalization, and state the conclusions that the evaluation supports.

*****

Course Code	:	MTOE-805
Course Title	:	Real Time System
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTOE

Course Objective: To study the basic of tasks and scheduling

- To understand programming languages and databases.
- To analyze real time communication.
- To analyze evaluation techniques and reliability models for Hardware Redundancy.
- To understand clock synchronization.

Course Content:

MODULE I - Introduction to Task Scheduling: Introduction - Issues in Real Time Computing, Structure of a Real Time System, Task classes, Performance Measures for Real Time Systems, Task Assignment and Scheduling – Classical uniprocessor scheduling algorithms, RM algorithm with different Cases-Priority ceiling precedence constraints- using of primary and alternative tasks.

MODULE II - Uni and Multi-Processor Scheduling: Uniprocessor scheduling of IRIS tasks, Task assignment, Utilization balancing – Next fit- Bin packing- Myopic off-line - Focused addressing and bidding- Buddy strategy- Fault Tolerant Scheduling. -Aperiodic scheduling - Spring algorithm, Horn algorithm- Bratley. - Sporadic scheduling.

MODULE III - Real Time Communication: Introduction - VTCSMA – PB CSMA- Deterministic collision resolution protocol- DCR for multi packet messages- dynamic planning based- Communication with periodic and aperiodic messages.

MODULE IV - Real Time Databases: Basic Definition, Real time Vs General purpose databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency control issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time System.

MODULE V - Real-Time Modelling and Case Studies: Petrinets and applications in real-time modelling, Air traffic controller system – Distributed air defence system**.**

Text Books:

1. C.M. Krishna, Kang G. Shin, "Real Time Systems", Tata McGraw - Hill, 2010.
2. Giorgio C. Bortuzzo, "Hard real-time computing systems: predictable scheduling algorithms and applications", Springer, 2008.

References:

1. C. Siva Ram Murthy, G. Manimaran, "Resource management in real-time systems and networks", PHI, 2009.

Alternative NPTEL/SWAYAM Course:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Real Time Systems	Prof. Rajib Mall	IIT Kharagpur

Course Outcomes:

1. To understand advanced concepts in theory of computer science;
2. To understand advanced concepts in applications of computer science;

3. To apply knowledge of advanced computer science to formulate the problems in computing and solve them;
4. To learn emerging concepts in theory and applications of computer science;
5. To design and conduct experiments as well as to analyze and interpret data;

*****

Course Code	:	MTOE-806
Course Title	:	Artificial Neural Network
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Course Category	:	MTOE

Course Objective:

1. To understand the biological neural network and to model equivalent neuron models.
2. To understand the architecture, learning algorithms and issues of various feed forward and feedback neural networks.

Course Content:

MODULE – I

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process

MODULE – II

Single Layer Perceptron: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection.

MODULE – III

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues, and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning.

MODULE – IV

Introduction to Deep Learning**,** Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network

Text Books:

1. Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.

References:

1. Artificial Neural Networks – B. Yegnanarayana Prentice Hall of India P Ltd 2005
2. Neural Networks in Computer Intelligence, Li Min Fu TMH 2003
3. Neural Networks -James A Freeman David M S Kapura Pearson Education 2004.
4. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Course Outcomes:

1. To Create different neural networks of various architectures both feed forward and feed backward.
2. To Perform the training of neural networks using various learning rules.
3. To Perform the testing of neural networks and do the analysis of these networks for various pattern recognition applications.

*****

Appendix – III

A Guide to Induction Program

Appendix – III: A Guide to Induction Program

1. Introduction

(*Induction Program was discussed and approved for all colleges by AICTE in March 2017. It was discussed and accepted by the Council of IITs for all IITs in August 2016. It was originally proposed by a Committee of IIT Directors and accepted at the meeting of all IIT Directors in March 2016.*[1] *This guide has been prepared based on the Report of the Committee of IIT Directors and the experience gained through its pilot implementation in July 2016 as accepted by the Council of IITs. Purpose of this document is to help institutions in understanding the spirit of the accepted Induction Program and implementing it.)*

Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond.

The graduating student must have knowledge and skills in the area of his study. However, he must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he would understand and fulfill his responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.

There is a mad rush for engineering today, without the student determining for himself his interests and his goals. This is a major factor in the current state of demotivation towards studies that exists among UG students.

The success of gaining admission into a desired institution but failure in getting the desired branch, with peer pressure generating its own problems, leads to a peer environment that is demotivating and corrosive. Start of hostel life without close parental supervision at the same time, further worsens it with also a poor daily routine.

To come out of this situation, a multi-pronged approach is needed. One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character.

---

[1] *A Committee of IIT Directors was setup in the 152nd Meeting of IIT Directors on 6th September 2015 at IIT Patna, on how to motivate undergraduate students at IITs towards studies, and to develop verbal ability. The Committee submitted its report on 19th January 2016. It was considered at the 153rd Meeting of all IIT Directors at IIT Mandi on 26 March 2016, and the accepted report came out on 31 March 2016. The Induction Program was an important recommendation, and its pilot was implemented by three IITs, namely, IIT(BHU), IIT Mandi and IIT Patna in July 2016. At the 50th meeting of the Council of IITs on 23 August 2016, recommendation on the Induction Program and the report of its pilot implementation were discussed and the program was accepted for all IITs.*

2. Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days.

We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.[2]

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

---

[2]*Induction Program as described here borrows from three programs running earlier at different institutions: (1) Foundation Program running at IIT Gandhinagar since July 2011, (2) Human Values course running at IIIT Hyderabad since July 2005, and (3) Counselling Service or mentorship running at several IITs for many decades. Contribution of each one is described next.*

IIT Gandhinagar was the first IIT to recognize and implement a special 5-week Foundation Program for the incoming 1st year UG students. It took a bold step that the normal classes would start only after the five week period. It involved activities such as games, art, etc., and also science and other creative workshops and lectures by resource persons from outside.

IIIT Hyderabad was the first one to implement a compulsory course on Human Values. Under it, classes were held by faculty through discussions in small groups of students, rather than in lecture mode. Moreover, faculty from all departments got involved in conducting the group discussions under the course. The content is non-sectarian, and the mode is dialogical rather than sermonising or lecturing. Faculty were trained beforehand, to conduct these discussions and to guide students on issues of life.

Counselling at some of the IITs involves setting up mentor-mentee network under which 1st year students would be divided into small groups, each assigned a senior student as a student guide, and a faculty member as a mentor. Thus, a new student gets connected to a faculty member as well as a senior student, to whom he/she could go to in case of any difficulty whether psychological, financial, academic, or otherwise.
The Induction Program defined here amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building physical activity, creativity, bonding, and character. It develops sensitivity towards self and one's relationships, builds awareness about others and society beyond the individual, and also in bonding with their own batch-mates and a senior student besides a faculty member.

Scaling up the above amalgamation to an intake batch of 1000 plus students was done at IIT(BHU), Varanasi starting from July 2016.

2.1. Physical Activity

This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop team work. Each student should pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity where labour yields fruits from nature.

2.2. Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program.
These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, flow into engineering design later.

2.3. Universal Human Values

It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting staff in the hostel and department, be sensitive to others, etc. Need for character building has been underlined earlier. A Module in Universal Human Values provides the base.

Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.
The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute. Experiments in this direction at IIT(BHU) are noteworthy and one can learn from them.[3]

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It is to open thinking towards the self. Universal Human Values discussions could even continue for rest of the semester as a normal course, and not stop with the induction program.

Besides drawing the attention of the student to larger issues of life, it would build relationships between teachers and students which last for their entire 4-year stay and possibly beyond.

---

[3]The Universal Human Values Course is a result of a long series of experiments at educational institutes starting from IIT-Delhi and IIT Kanpur in the 1980s and 1990s as an elective course, NIT Raipur in late 1990s as a compulsory one-week off campus program. The courses at IIT(BHU) which started from July 2014, are taken and developed from two compulsory courses at IIIT Hyderabad first introduced in July 2005.

2.4. Literary

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

2.5. Proficiency Modules

This period can be used to overcome some critical lacunas that students might have, for example, English, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. We hope that problems arising due to lack of English skills, wherein students start lagging behind or failing in several subjects, for no fault of theirs, would, hopefully, become a thing of the past.

2.6. Lectures by Eminent People

This period can be utilized for lectures by eminent people, say, once a week. It would give the students exposure to people who are socially active or in public life.

2.7. Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

2.8. Familiarization to Dept./Branch & Innovations

The students should be told about different method of study compared to coaching that is needed at IITs. They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

3. Schedule

The activities during the Induction Program would have an Initial Phase, a Regular Phase and a Closing Phase. The Initial and Closing Phases would be two days each.

3.1. Initial Phase

Day	Time	Activity
Day 0	Whole Day	Students Arrive – Hostel Allotment (Preferably do pre-allotment)
Day 1	09:00 AM – 03:00 PM	Academic Registration
	04:30 PM – 06:00 PM	Orientation
Day 2	09:00 AM – 10:00 AM	Diagnostic test (for English etc.)
	10:00 AM – 12:25 PM	Visit to respective depts.
	12:30 PM – 01:55 PM	Lunch
	02:00 PM – 02:55 PM	Director's address
	03:00 PM – 03:30 PM	Interaction with parents
	03:30 PM – 05:00 PM	Mentor-Mentee Groups - Introduction within group. (Same as Universal Human Values Group)

3.2. Regular Phase

After two days is the start of the Regular Phase of Induction. With this phase there would be regular program to be followed every day.

3.2.1. Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We first show a typical daily timetable.

DAY 3 Onwards

Session	Time	Activity	Remarks
	06:00 AM	Wake up Call	
I	06:30 AM – 07:10 AM	Physical Activity (Mild Exercise / Yoga)	
	07:15 AM – 08:55 AM	Bath, Breakfast etc.	
II	09:10 AM – 10:55 AM	Creative Arts / Universal Human Values	Half the groups do creative arts
III	11:00 AM – 12:55 PM	Creative Arts / Universal Human Values	Complementary Alternate Groups
	01:00 PM – 02:25 PM	Lunch	
IV	02:30 PM – 03:55 PM	Afternoon Session	See below
V	04:00 PM – 05:00 PM	Afternoon Session	See below
	05:00 PM – 05:25 PM	Break / Light Tea	
VI	05:30 PM – 06:45 PM	Games / Special Lectures	
	06:50 PM – 08:25 PM	Rest and Dinner	
VII	08:30 PM – 09:25 PM	Informal Interactions (In hostels)	

Sundays are off. Saturdays have the same schedule as above or have outings.

3.2.2. Afternoon Activities (Non-Daily)

The following five activities are scheduled at different times of the Induction Program, and are not held daily for everyone:

1. Familiarization to Dept./Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Here is the approximate activity schedule for the afternoons (may be changed to suit local needs):

Session	Activity	Remarks
IV	Familiarization with Dept./Branch & Innovations	For 3 Days (Day 3 to Day 5)
IV, V and VI	Visit to Local Area	For 3 Days – interspersed (e.g. Saturdays)

IV	Lectures by Eminent People	As scheduled 3-5 lectures
IV	Literary (Play / Literature / Book Reading)	For 3-5 Days
V	Proficiency Modules	Daily, but only for those who need it.

3.3. Closing Phase

Day	Time	Activity
Last But One Day	08:30 AM – 12:00 PM	Discussions and finalization of presentation within each group
	02:00 AM -05:00 PM	Presentation by each group in front of 4 other groups besides their own (about 100 students)
Last Day	Whole Day	Examinations (if any). May be extended to last 2 days, in case needed.

3.4. Follow Up after Closure

A question comes up as to what would be the follow up program after the formal 3-week Induction Program is over? The groups which are formed should function as mentor-mentee network. A student should feel free to approach his faculty mentor or the student guide, when facing any kind of problem, whether academic or financial or psychological etc. (For every 10 undergraduate first year students, there would be a senior student as a student guide, and for every 20 students, there would be a faculty mentor.) Such a group should remain for the entire 4-5-year duration of the stay of the student. Therefore, it would be good to have groups with the students as well as teachers from the same department/discipline[4].

Here we list some important suggestions which have come up and which have been experimented with:

3.4.1. Follow Up after Closure – Same Semester

It is suggested that the groups meet with their faculty mentors once a month, within the semester after the 3-week Induction Program is over. This should be a scheduled meeting shown in the timetable. (The groups are of course free to meet together on their own more often, for the student groups to be invited to their faculty mentor's home for dinner or tea, nature walk, etc.)

3.4.2. Follow Up – Subsequent Semesters

It is extremely important that continuity be maintained in subsequent semesters.
It is suggested that at the start of the subsequent semesters (up to fourth semester), three days be set aside for three full days of activities related to follow up to Induction Program. The students be shown inspiring films, do collective art work, and group discussions be conducted. Subsequently, the groups should meet at least once a month.

4. Summary

Engineering institutions were set up to generate well trained manpower in engineering with a feeling of responsibility towards oneself, one's family, and society. The incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents. As a result, most students fail to link up with the goals of their own institution.

The graduating student must have values as a human being, and knowledge and meta-skills related to his/her profession as an engineer and as a citizen. Most students who get demotivated to study engineering or their branch, also lose interest in learning.

The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

The Universal Human Values component, which acts as an anchor, develops awareness and sensitivity, feeling of equality, compassion and oneness, draw attention to society and nature, and character to follow through. It also makes them reflect on their relationship with their families and extended family in the college (with hostel staff and others). It also connects students with each other and with teachers so that they can share any difficulty they might be facing and seek help.

References:

Motivating UG Students Towards Studies, Rajeev Sangal, IITBHU Varanasi, Gautam Biswas, IIT Guwahati, Timothy Gonsalves, IIT Mandi, Pushpak Bhattacharya, IIT Patna, (Committee of IIT Directors).
31 March 2016, IIT Directors' Secretariat, IIT Delhi.

Contact: Prof. Rajeev Sangal, Director, IIT(BHU), Varanasi (director@iitbhu.ac.in).

*****

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION

Nelson Mandela Marg, Vasant Kunj, New Delhi 110070

www.aicte-india.org