CURRICULUM
for
UNDERGRADUATE DEGREE
(B. Tech) COURSES IN

ELECTRONICS &COMMUNICATION ENGINEERING

(Engineering & Technology)

With Minor Degree in Data Science & IoT

[Syllabus – 2023 onwards]

**Department of Electronics & Communication Engineering,
Dibrugarh University Institute of Engineering and
Technology,
Dibrugarh University
Dibrugarh, Assam - 786004 India**

Committee for Model Curriculum

S.No	Name	Designation & Organization
1	**Prof. R K Shevgaonkar**	Professor IIT Bombay **(Chairman)**
2	**Prof. Mahesh B. Patil**	Professor IIT Bombay **(Member)**
3	**Prof. Rajendra Patrikar**	Professor, Centre for VLSI and Nano Technology, Visvesvaraya National Institute of Technology, Nagpur, Maharashtra **(Member)**
4	**Prof S P Mahajan**	Professor, COEP, Pune **(Member)**
5	**Dr. Raja Datta**	Professor, IIT Kharagpur **(Member)**
6	**Dr. Kushal R. Tuckley**	AGV Systems Pvt Ltd, Mumbai **(Member)**

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 Electronics and Communication Engineering (ECE). 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 161 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. R K Shevgaonkar, Prof Mahesh B. Patil, Prof. Rajendra Patrikar, Prof S P Mahajan, Dr. Raja Datta, Dr. Kushal R. Tuckley and other committee members. 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 160 credits.

(Prof. T G Sitharam)
Chairman
All India Council for Technical Education

PREFACE

Taking cognizance 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 revised model curriculum of UG Course in Electronics and Communication Engineering (ECE). During the development of curriculum, the employability and employment opportunities for graduates, future ready workforce who will be skilled enough to handle the rapid growth in the field of Semiconductor, 5G, VLSI Design and Technology 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.
- Introduction of Design Thinking and Universal Human Value course.

Thanks for the time and efforts of the members of the working group Chaired by Prof. R K Shevgaonkar and which included Prof Mahesh B. Patil, Prof. Rajendra Patrikar, Prof S P Mahajan, Dr. Raja Datta, Dr. Kushal R. Tuckley and other committee members.

Special thanks to Prof. T G Sitharam, Chairman; Dr. Abhay Jere, 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, and the dedicated efforts of Dr. Naveen Arora, Assistant Director (P&AP); Dr. Anil Sharma, Assistant Director (P&AP), Mr. Rakesh Kumar Pandit, Young Professional (P&AP); and other office staff of AICTE.

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Dr. Ramesh Unnikrishnan
Advisor – II (P&AP)

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GENERAL COURSE STRUCTURE & CREDIT DISTRIBUTION

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 160 credits, the total number of credits proposed for the four-year B. Tech/B.E. in Electronics and Communication Engineering (ECE) is kept as 160.

C. Structure of UG Program in Electronics and Communication Engineering (ECE):
The structure of UG program in Electronics and Communication Engineering (ECE) shall have essentially the following categories of courses with the breakup of credits as given:

S.No.	Category	Credit Breakup for ECE
1	Humanities and Social Sciences including Management courses	15
2	Basic Science courses	23
3	Engineering Science courses including workshop, drawing, basics of electronics/electrical/mechanical/computer etc.	17
4	Professional core courses	61
5	Professional Elective courses relevant to chosen specialization/branch	12
6	Open subjects – Electives from other technical and /or emerging subjects	12
7	Project work, seminar and internship in industry or elsewhere	24
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
9	Skill Based Course	6
	Total	**173**

Minor variation is allowed as per need of the respective disciplines.

D. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses

HSMC	Humanities and Social Sciences including Management courses
EC	Program core courses
PE	Program Elective courses
OE	Open Elective courses
LC	Laboratory course
MC	Mandatory courses
OE	Open Elective courses
LC	Laboratory course
MC	Mandatory courses

> **Course level coding scheme:** Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g.
> 101, 102 … etc. for first year.
> 201, 202 …. Etc. for second year.
> 301, 302 … for third year.

> **Category-wise Courses**

HUMANITIES & SOCIAL SCIENCES COURSES [HSM]

(i) Number of Humanities & Social Science Courses: 5
(ii) Credits: 15

Sl. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	HSM-01	English for Technical Writing	I	2	0	2	3
2	HSM-02	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	II	2	1	0	3
4	HSM-03	Management-I (Organizational Behaviour)/ Finance & Accounting	IV	3	0	0	3
5	HSM-04	Humanities – I	V	3	0	0	3
6	HSM-05	Humanities – II	VII	3	0	0	3
Total Credits							**15**

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BASIC SCIENCE COURSE [BSC]

Sl. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	BS-01	Physics-I (Oscillation, Waves and Optics)	I	3	1	2	5
2	BS-02	Mathematics-I	I	3	1	0	4
3	BS-03	Chemistry-I	II	3	0	2	4
4	BS-04	Mathematics-II (Probability and Statistics)	II	3	1	0	4
5	BS-05	Biology for Engineers	II	3	0	0	3
6	BS-05	Slot for BS	III	3	0	0	3
Total Credits							23

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ENGINEERING SCIENCE COURSE [ESC]

Sl. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	ES-01	Basic Electrical Engineering	I	2	1	2	4
2	ES-02	Engineering Graphics & Design	I	1	0	4	3
3	ES-03	Design Thinking	I	0	0	2	1
4	ES-04	Programming for Problem Solving	II	2	0	4	4
5	ES-05	Digital Fabrication / Workshop/Manufacturing Practices	II	0	0	4	2
6	ES-06	Numerical Techniques	IV	2	0	2	3
Total Credits							17

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Program Core Courses:

Sr. No.	Course Code	Course Title	Preferred Semester	Hrs /Week L: T: P	Credits
1	EC01	Electronic Devices	III	3:0:0	3
2	EC02	Electronics Devices Lab	III	0:0:2	1
3	EC03	Digital System Design	III	3:0:0	3
4	EC04	Digital System Design Lab	III	0:0:2	1
5	EC05	Signals and Systems	III	3:0:0	3
6	EC06	Network Theory	III	3:0:0	3
7	EC07	Probability Theory and Stochastic Processes	III	2:1:0	3

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8	EC08	Analog and Digital Communication	IV	3:0:0	3
9	EC09	Analog and Digital Communication Lab	IV	0:0:2	1
10	EC10	Analog Circuits	IV	3:0:0	3
11	EC11	Analog Circuits Lab	IV	0:0:2	1
12	EC12	Microcontrollers	IV	3:0:0	3
13	EC13	Microcontrollers Lab	IV	0:0:2	1
14	EC14	Digital Signal Processing	V	3:1:0	4
15	EC15	Digital Signal Processing Lab	V	0:0:2	1
16	EC16	Electromagnetic Waves	V	3:1:0	4
17	EC17	Electromagnetic Waves Lab	V	0:0:2	1
18	EC18	Computer Architecture	V	3:0:0	3
19	EC19	Control Systems	V	3:0:0	3
20	EC20	Embedded Systems	V	3:0:0	3
21	EC-21	Embedded Systems Lab	V	0:0:2	1
22	EC-22	Computer Networks	VI	3:0:0	3
23	EC-23	Computer Networks Lab	VI	0:0:2	1
24	EC-24	VLSI Design	VI	3:0:0	3
25	EC-25	VLSI Design Lab	VI	0:0:2	1
26	EC-26	Mobile Communication and Networks	VI	3:1:0	4
27	EC-27	Seminar	VII	0:0:2	1
28	EC-28	Internship /Project Phase-I	VII	6 week	2
Total					**64**

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Project:

Sr. No.	Course Code	Course Title	Preferred Semester	Hrs /Week L: T: P	Credits
1	EC-P1	Micro Project	IV	0: 0: 4	2
2	EC-P2	Mini Project	VI	0: 0: 6	3
3	EC-P3	Project	VIII	0: 0: 24	12
Total					**17**

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Program Elective Courses:

Sr. No.	Course Code	Course Title	Hrs /Week L: T: P	Credits
1	ECEL1	Microwave Theory and Techniques	3:0:0	3
2	ECEL2	Fiber Optic Communications	3:0:0	3
3	ECEL3	Information Theory and Coding	3:0:0	3
4	ECEL4	Digital Audio Processing	3:0:0	3
5	ECEL5	Introduction to MEMS	3:0:0	3
6	ECEL6	Adaptive Signal Processing	3:0:0	3
7	ECEL7	Antennas and Propagation	3:0:0	3
8	ECEL8	Bio-Medical Electronics	3:0:0	3
9	ECEL9	Advanced Mobile Communications	3:0:0	3
10	ECEL10	Digital Image Processing	3:0:0	3
11	ECEL11	Mixed Signal Design	3:0:0	3
12	ECEL12	Wireless Sensor Networks	3:0:0	3
13	ECEL13	Power Electronics	3:0:0	3
14	ECEL14	Satellite Communication	3:0:0	3
15	ECEL15	High Speed Electronics	3:0:0	3
16	ECEL16	Nanoelectronics	3:0:0	3
17	ECEL17	Data Structures	3:0:0	3
18	ECEL18	Internet of Things	3:0:0	3
19	ECEL19	Cyber Security	3:0:0	3
20	ECEL20	Machine Learning	3:0:0	3

NOTE- The institute may offer suitable additional electives based on the expertise available or in Online Mode from SWAYAM.

Open Elective Course:-

Course Title	Hrs. /Week L: T: P	Credits
1. Optimization Techniques 2. Real Time Operating Systems 3. Robotics 4. Microwave Devices and Circuits 5. Electrical Machine 6. Satellite Communication 7. IC Technology 8. Advanced Control system 9. Artificial Intelligence. 10. Reverse Engineering. 11. Yoga and Sports science. 12. Cyber Security. 13. Material Science. 14. Microelectronics 15. Human Values and professional ethics. 16. Operation research 17. Big data analytics 18. Electric Vehicles 19. Renewable Energy 20. Information and communication technology (ICT) 21. Internet of Things (IOT) 22. Software Engineering. 23. VLSI 24. Pattern Recognition 25. Integrated optics and photonic system 26. Radar Engineering 27. Mixed Signal Circuit Design 28. Low Power VLSI Design 29. Secure Communication 30. Machine Learning 31. Object Oriented Programming (C++) 32. Python 33. Deep Learning 34. Smart Farming 35. Concurrent Engineering 36. Communication System and Sensor 37. Military Electronics System Engineering.	3:0:0 (ALL SUBJECTS)	3

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 II.**

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 for the students of each branch.

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 Courses:**
(The weightage of Internal assessment is 40% and for End Semester Exam is 60%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

b. **For Practical Courses:**
(The weightage of Internal assessment is 60% and for End Semester Exam is 40%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

c. **For Summer 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)
-	F^R (Fail due to shortage of attendance and therefore, to repeat the course)

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Bridge Courses for exit:

2-Months internship for 6-Credits

OR

Two courses mentioned below of 6 credits.

A. After First Year:

The candidate should pass the following two additional courses **(ITI Level)**

OR

any two suitable skill based courses to qualify for Certification**.**

1. Consumer Electronic/Radio Engineering /Digital Electronics **(Any one course)**
2. Electronics Servicing and Maintenance

B. After Second Year:

The candidate should pass the following two additional courses **(Diploma Level)**

OR

any two suitable skill based courses to qualify for Diploma.

1. Data Communication and Networking
2. Electronics Servicing and Maintenance

C. After Third Year:

The candidate should pass following additional courses **(Degree Level)**

OR

any two suitable skill based courses to qualify for B. Voc

1. Advanced Mobile Communication
2. Cyber Security

SEMESTER WISE STRUCTURE

SEMESTER I

S. No.	Course Code	Course Title	L	T	P	Credit
3 WEEKS COMPULSORY INDUCTION PROGRAM (UHV-I)						
1	BS-101 (T)	Physics-I(Oscillation, Wave sand Optics)	3	1	0	4
2	BS-101 (P)	Physics-I Lab	0	0	2	1
3	BS-102	Mathematics-I	3	0	0	3
4	ES-101 (T)	Basic Electrical Engineering	2	0	0	2
5	ES-101 (P)	Basic Electrical Engineering Lab	0	0	2	1
6	ES-102 (T)	Engineering Graphics & Design	1	0	0	1
7	ES-102 (P)	Engineering Graphics & Design Lab	0	0	4	2
8	HSMC-101 (T)	English for Technical Writing	2	0	0	2
9	HSMC-101 (P)	English for Technical Writing Lab	0	0	2	1
10	ES-103	Design Thinking	0	0	2	1
11	AU-101	Workshop	2	0	4	0
12	SBC-EC-101	Skill Based Course (Semiconductor devices and Application)	1	0	4	3
TOTAL			**14**	**1**	**20**	**21**

SEMESTER II

S. No.	Course Code	Course Title	L	T	P	Credit
1	BS-201 (T)	Chemistry	3	0	0	3
2	BS-201 (P)	Chemistry Lab	0	0	2	1
3	BS-202	Mathematics-II	3	1	0	4
4	ES-201 (T)	Programming for Problem Solving	2	0	0	2
5	ES-201 (P)	Programming for Problem Solving Lab	0	0	4	2
6	BS-203	Biology for Engineers	3	0	0	3
7	ES-202 (T)	Digital Fabrication/ Workshop/Manufacturing Practices	1	0	0	1
8	ES-202 (P)	Digital Fabrication/ Workshop/Manufacturing Practices Lab	0	0	4	2
9	HSM-201	Universal Human Values	2	1	0	3
10	AU-202	Sports and Yoga or NSS/NCC	2	0	2	0
11	SBC-EC-201	Skill Based Course (Repairing and maintenance of Domestic Electronics Appliances)	1	0	4	3
TOTAL			**17**	**2**	**16**	**24**

SEMESTER-III

S. No.	Course Code	Course Title	L	T	P	Credit
1	EC301 (T)	Electronic Devices	3	0	0	3
2	EC301 (P)	Electronic Devices Lab	0	0	2	1
3	EC302 (T)	Electromagnetic Waves	3	0	0	3
4	EC302 (P)	Electromagnetic Waves Lab	0	0	2	1
5	EC303	Signals and Systems	3	0	0	3
6	EC304	Network Theory	3	0	0	3
7	EC305	Probability Theory and Stochastic Processes	2	1	0	3
8	MC201	Indian Knowledge System	2	0	0	2
9	SBC-EC- 301	Skill Based Course (Embedded design and application)	1	0	2	3
10	AU301	Soft Skill				0
TOTAL						**22**

SEMESTER-IV

S. No.	Course Code	Course Title	L	T	P	Credit
1	EC402 (T)	Analog Circuits	3	0	0	3
2	EC402 (P)	Analog Circuits Lab	0	0	2	1
3	EC403 (T)	Microcontrollers	3	0	0	3
4	EC403 (P)	Microcontrollers Lab	0	0	2	1
5	EC401 (T)	Analog and Digital Communication	3	0	0	3
6	EC401 (P)	Analog and Digital Communication Lab	0	0	2	1
7	ECP401	Micro Project	0	0	4	2
8	EC-404	Numerical Techniques	2	0	2	3
9	HSMC401	Managerial Economics	3	0	0	3
10	ECT401	Social and Rural Internship				2
11	SBC-EC-401	Skill Based Course (PCB design and Fabrication)	1	0	2	3
12	ECO401	Environmental Studies				0
TOTAL						**25**

SEMESTER-V

S. No.	Course Code	Course Title	L	T	P	Credit
1	EC-505 (T)	Digital Signal Processing	3	1	0	4
2	EC-505 (P)	Digital Signal Processing Lab	0	0	2	1
3	EC501 (T)	Digital System Design	3	1	0	4
4	EC501 (P)	Digital System Design Lab	0	0	2	1
5	EC504	Computer Architecture	3	0	0	3
6	EC-502	Control Systems	3	0	0	3
7	EC-503 (T)	Embedded Systems	3	0	0	3
8	EC-503 (P)	Embedded Systems Lab	0	0	1	1
9	HSMC501	Management & Accountancy				2
10	AU501	Slot for Professional Ethics				0
11	ECT501	Academic Internship				2
TOTAL						**24**

SEMESTER-VI

S. No.	Course Code	Course Title	L	T	P	Credit
1	EC-601 (T)	Computer Networks	3	0	0	3
2	EC-601 (P)	Computer Networks Lab	0	0	2	1
3	EC-602 (T)	VLSI Design	3	0	0	3
4	EC-602 (P)	VLSI Design Lab	0	0	2	1
5	EC-603	Mobile Communication and Networks	3	1	0	4
6	ECEL601	ProgramElective-1	3	0	0	3
7	ECOE601	OpenElective-1(Preferably subject like : i) Smart Farming ii) Concurrent Engineering)	3	0	0	3
8	EC-604	Mini Project	0	0	6	3
TOTAL						**21**

SEMESTER-VII

S. No.	Course Code	Course Title	L	T	P	Credit
1	ECEL701	ProgramElective-2	3	0	0	3
2	ECEL702	ProgramElective-3	3	0	0	3
3	ECOE-701	OpenElective-2	3	0	0	3
4	ECOE-702	OpenElective-3	3	0	0	3
5	EC-701	Organisational Behaviour	3	0	0	3
6	ECS701	Seminar	0	0	2	1
7	ECT 701	Internship (Industrial)	0	0	4	2
		TOTAL				18

Note-Minimum6weeksInternshipafterthesixthsemester

SEMESTER-VIII

S. No.	Course Code	Course Title	L	T	P	Credit
1	ECEL-801	ProgramElective-4	3	0	0	3
2	ECOE-801	OpenElective-4	3	0	0	3
3	ECP-801	Project	0	0	20	10
4	EGV-801	Grand Viva				2
		TOTAL				18

Overall Credit - 162 (without minor course)/Overall Credit -

NOTE - In case of semester-long project work done in industry the PE-04 and OE-04 may be offered in online mode.

(ECEL: Course to be selected from the list of Program Electives)

SEMESTER – I

SEMESTER I

Course Code	:	BS -01
Course Title	:	Physics- I
Number of Credits	:	5 (L: 3, T: 1, P: 2)
Course Category	:	Basic Science Courses
Course Contents in Physics	:	**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.

1. 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

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2. 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. Introduction to Mechanics — MK Verma
3. An Introduction to Mechanics — D Kleppner & R Kolenkow
4. Principles of Mechanics — JL Synge & BA Griffiths
5. Mechanics — JP Den Hartog
6. Engineering Mechanics - Dynamics, 7th ed. - JL Meriam
7. Mechanical Vibrations — JP Den Hartog
8. 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

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3. 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/

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4. 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, CO_2), 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/

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Course Code	:	BS-02
Course Title	:	Mathematics- I
Number of Credits	:	4 (L: 3, T: 1, P: 0)
Course Category	:	Basic Science Courses

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 1: Basic Calculus: (6 hours)
Curvature, 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.

Module 2: Single-variable Calculus (Differentiation): (6 hours)
Rolle's Theorem, Mean value theorems and applications; Extreme values of functions; Linear approximation; Indeterminate forms and L'Hospital's rule.

Module 3: Sequences and series: (10 hours)
Limits of sequence of numbers, Calculation of limits, Infinite series; Tests for convergence; Power series, Taylor and Maclaurin series; Taylor theorem, convergence of Taylor series, error estimates.

Module 4: Multivariable Calculus (Differentiation): (8 hours)
Limit, continuity and partial derivatives, directional derivatives, gradient, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 5: **Multivariable Calculus (Integration):** (10 hours)
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, Gradient, curl and divergence, Theorems of Green, Gauss and Stokes.

TEXTBOOKS/REFERENCES:

1. AICTE's Prescribed Textbook: Mathematics-I (Calculus & Linear Algebra), Khanna Book Publishing Co.
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.

4. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
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.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind:
   (1) Module 1: The relevant sections from Chapters 2, 6 and 11 of [3].
   (2) Module 2: Sections 3.1, 3.2, 3.3, 3.7 & 6.6 of [1].
   (3) Module 3: Sections 8.1-8.6, 8.8-8.10 of [1].
   (4) Module 4: Sections 12.1-12.5, 12.7-12.9 of [1].
   (1) Module 5: Sections 13.1 – 13.7, 14.1 – 14.8 of [1].

Course outcomes: The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate differentiation and integration. 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.
- The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- 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 acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

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Course Code	:	ES-01
Course Title	:	Basic Electrical Engineering
Number of Credits	:	4 (L: 2, T: 1, P: 2)
Course Category	:	Engineering Science Courses

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. AICTE's Prescribed Textbook: Basic Electrical Engineering, Khanna Book Publishing.
2. Ritu Sahdev (2022), Basic Electrical Engineering, Khanna Book Publishing.
3. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.
4. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
5. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
6. 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.

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Course Code	:	**ES-02**
Course Title	:	**Engineering Graphics & Design**
Number of Credits	:	**3 (L: 1, T: 0, P: 4)**
Course Category	:	**Engineering Science Courses**

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: Customisation & 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. AICTE's Prescribed Textbook: Engineering Graphics & Design Khanna Book Publishing.
2. Jain, Maheshwari, Gautam (2021), Engineering Graphics & Design, Khanna Book Publishing.
3. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
5. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
7. (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.

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Course Code	:	**HSM-01**
Course Title	:	**English for Technical Writing**
Number of Credits	:	**3 (L: 2, T: 0, P: 2)**
Course Category	:	**Humanities & Social Science Courses**

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
Root words from foreign languages and their use in English

Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
Synonyms, antonyms, and standard abbreviations.

Module II: Basic Writing Skills
Sentence Structures
Use of phrases and clauses in sentences
Importance of proper punctuation
Creating coherence
Organizing principles of paragraphs in documents
Techniques for writing precisely

Module III: Identifying Common Errors in Writing
Subject-verb agreement
Noun-pronoun agreement
Misplaced modifiers
Articles
Prepositions
Redundancies
Clichés

Module IV: Nature and Style of sensible Writing
Describing
Defining
Classifying
Providing examples or evidence
Writing introduction and conclusion

Module V: Writing Practices
Comprehension
Précis Writing
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. AICTE's Prescribed Textbook: English (with Lab Manual), Khanna Book Publishing Co.
2. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
3. Practical English Usage. Michael Swan. OUP. 1995.
4. Remedial English Grammar. F.T. Wood. Macmillan.2007
5. On Writing Well. William Zinsser. Harper Resource Book. 2001
6. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

7. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

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.

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Course Code	:	**ES-03**
Course Title	:	**Design Thinking**
Number of Credits	:	**1 (L: 0, T: 0, P: 2)**
Course Category	:	**Engineering Science Courses**

COURSE OBJECTIVE(S):
The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

COURSE CONTENTS:
Unit 1: An Insight to Learning

Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting

Unit 2: Remembering Memory

Understanding the Memory process, Problems in retention, Memory enhancement techniques

Unit 3: Emotions: Experience & Expression

Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers

Unit 4: Basics of Design Thinking

Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – **Empathize, Define, Ideate, Prototype, Test**

Unit 5: Being Ingenious & Fixing Problem

Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving

Unit 6: Process of Product Design

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, **Assignment – Engineering Product Design**

Unit 7: Prototyping & Testing

What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, **Sample Example**, Test Group Marketing

Unit 8: Celebrating the Difference

Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences

Unit 9: Design Thinking & Customer Centricity

Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

Unit 10: Feedback, Re-Design & Re-Create

Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – **"Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".**

Course Outcomes (CO):

Student will able to
1. Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
2. Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
3. Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products
4. Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, techniques during prototype development
5. Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

Text/Reference Books:

1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.

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Course Code	:	AU-01
Course Title	:	IDEA Lab Workshop
Number of Credits	:	0 (L: 2, T: 0, P: 4)
Course Category	:	AU-101
Prerequisites	:	None

Course Objectives:

1. To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
2. Learn useful mechanical and electronic fabrication processes.
3. Learn necessary skills to build useful and standalone system/ project with enclosures.
4. Learn necessary skills to create print and electronic documentation for the system/project

Course Contents:

Unit #	Topics	
1	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,
2	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.

	multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.	
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverse engineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4.	Discussion and implementation of a mini project.	
5.	Documentation of the mini project (Report and video).	

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.

6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

S. No.	Title
1.	AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing.
2.	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13: 978-9386173393, Khanna Book Publishing Company, New Delhi.
3.	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4.	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5.	The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6.	The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978-1681881584.
7.	Make: Tools: How They Work and How to Use Them. Platt, Charles. Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8.	The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9.	Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
10.	Encyclopedia of Electronic Components (Volume 1, 2 and 3). Charles Platt. Shroff Publishers. ISBN-13: 978-9352131945, 978-9352131952, 978-9352133703
11.	Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586

12.	Programming Arduino: Getting Started with Sketches. 2nd edition. Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13.	Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13 : 978-1260019193.
14.	Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773
15.	Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer.
16.	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17.	Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

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SEMESTER – II

SEMESTER II

Course Code	:	BS-03
Course Title	:	Chemistry- I
Number of Credits	:	4 (L: 3, T: 0, P: 2)
Course Category	:	Basic Science Course

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. AICTE's Prescribed Textbook: Chemistry – I with Lab Manual, Khanna Book Publishing.
2. Engineering Chemistry, by Manisha Agrawal.
3. University chemistry, by B. H. Mahan
4. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
6. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
7. Physical Chemistry, by P. W. Atkins
8. 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.

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Course Code	:	BS-04
Course Title	:	Mathematics- II
Number of Credits	:	4 (L: 3, T: 1, P: 0)
Course Category	:	Basic Science Course

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

Course Content:

Module 1: Matrices (10 hours)
Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.

Module 2: First order ordinary differential equations: (6 hours)
Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders: (8 hours)
Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation: (8 hours):
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 5: Complex Variable – Integration: (8 hours):
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.

TEXTBOOKS/REFERENCES:

1. AICTE's Prescribed Textbook: Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable), Khanna Book Publishing Co.
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
11. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.
12. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
13. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Note: The modules have been prepared keeping the following from the Textbooks/References in mind:
   (1) Module 1: Sections 7.3-7.5, 7.7, 7.8, 8.1-8.4 of [1].
   (2) Module 2: Sections 1.4, 1.5 of [1]; Section 5.1 of [2].
   (3) Module 3: Sections 2.5, 2.6, 2.10, 5.1, 5.3, 5.4, 5.5 of [1].
   (4) Module 4: Sections 13.3 – 13.7, 17.1 – 17.3 of [1].
   (5) Module 5: Sections 14.1 – 14.4, 15.2 – 15.4, 16.1 – 16.4 of [1].

COURSE OUTCOMES: The objective of this course is to familiarize the prospective engineers with techniques in matrices, ordinary 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:
- The essential tool of matrices and linear algebra in a comprehensive manner.

- The effective mathematical tools for the solutions of differential equations that model physical processes.
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

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Course Code	:	**ES-04**
Course Title	:	**Programming for Problem Solving**
Number of Credits	:	**4 (L: 2, T: 0, P: 4)**
Course Category	:	**Engineering Science Courses**

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. AICTE's Prescribed Textbook: Programming for Problem Solving, Khanna Book Publishing Co.
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?do

		main=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.

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BS-05	Biology (Biology for Engineers)	2L:1T:0P	3 credits

Module 1. Introduction

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry
Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2. Classification

Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.
Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata-acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Module 3 -Genetics

Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"
Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.
Module 4.-Biomolecules

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine
Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids

Module 5. Enzymes

Purpose: To convey that without catalysis life would not have existed on earth
Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyze reactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples.

Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6. Information Transfer

Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. DICOM Image formats, The DNA Technology (Use and Application) Regulation Bill, 2019

Module 7. Macromolecular analysis

Purpose: How to analyses biological processes at the reductionistic level
Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8.- Metabolism

Purpose: The fundamental principles of energy transactions are the same in physical and biological world.
Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge

Module 9. Microbiology

Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

References:

1) General Biology, Uma Devi Koduru, Khanna Book Publishing Company.
2) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
3) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
4) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
5) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
6) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Outcomes

After studying the course, the student will be able to:
- Describe how biological observations of 18th Century that lead to major discoveries.
- Convey that classification *per se* is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
- Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
- Classify enzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Analyse biological processes at the reductionistic level
- Apply thermodynamic principles to biological systems.
- Identify and classify microorganisms

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Course Code	:	ES-05
Course Title	:	**Digital Fabrication / Workshop/Manufacturing Practices**
Number of Credits	:	**2 (L: 0, T: 0, P: 4)**
Course Category	:	**Engineering Science Courses**

ES- 05	Digital Fabrication	0L:0T:4P	2 credits

Course Objective:

 The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Course Content:

1. 3D Printing (Additive Manufacturing)

 Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing   processes, Applications.

2. CAD for Additive Manufacturing

   CAD Data formats, Data translation, Data loss, STL format.

3. Additive Manufacturing Techniques

Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.
Process, Process parameter, Process Selection for various applications.
   Additive Manufacturing Application Domains: Aerospace, Electronics, Health
   Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. Materials

Polymers, Metals, Non-Metals, Ceramics
   Various forms of raw material- Liquid, Solid, Wire, Powder; Powder
    Preparation
    and their desired properties, Polymers and their properties.
Support Materials

5. Additive Manufacturing Equipment

Process Equipment- Design and process parameters
Governing Bonding Mechanism
Common faults and troubleshooting
Process Design

6. Post Processing: Requirement and Techniques

7. Product Quality

Inspection and testing

Defects and their causes

LIST OF PRACTICALS

3. 3D Modelling of a single component.
4. Assembly of CAD modelled Components
5. Exercise on CAD Data Exchange.
5. Generation of .stl files.
6. Identification of a product for Additive Manufacturing and its AM process plan.
7. Printing of identified product on an available AM machine.
8. Post processing of additively manufactured product.
9. Inspection and defect analysis of the additively manufactured product.
10. Comparison of Additively manufactured product with conventional manufactured counterpart.

Text/Reference Books:

1. AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing Co.
2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies:
   Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
3. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid
   Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
4. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi.
5. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
6. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in
   Material Science, 2013.
7. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
8. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM)
   Processes of Titanium Alloy", InTech, 2012.

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

1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate. stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM).

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| ES- 05 | Workshop/Manufacturing Practices | 0L:0T:4P | 2 credits |

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

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HSM (H-102)	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	2L:1T:0P	3 Credits

Pre-requisites: None. Universal Human Values 1 (Desirable)

1- COURSES ON HUMAN VALUES

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.

Objectives of UHV-II Course
This introductory course input is intended:
1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.

2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Salient Features of the Course

The salient features of this course are:

1. It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.
2. The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.
3. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
4. While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. The course is in the form of 28 lectures (discussions) and 14 practice sessions.
3. It is free from any dogma or value prescriptions.
4. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.
5. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.
6. This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

2- COURSE TOPICS

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 01-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

The syllabus for the lectures and practice sessions is given below:

Module 1 – Introduction to Value Education (6 lectures and 3 tutorials for practice session)

> **Lecture 1:** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
> **Lecture 2:** Understanding Value Education
> **Tutorial 1**: **Practice Session PS1**   Sharing about Oneself
> **Lecture 3:** Self-exploration as the Process for Value Education
> **Lecture 4:** Continuous Happiness and Prosperity – the Basic Human Aspirations
> **Tutorial 2: Practice Session PS2**   Exploring Human Consciousness
> **Lecture 5:** Happiness and Prosperity – Current Scenario
> **Lecture 6:** Method to Fulfill the Basic Human Aspirations
> **Tutorial 3: Practice Session PS3**   Exploring Natural Acceptance

Expected outcome:

The students start exploring themselves: get comfortable with each other and with the teacher; they start appreciating the need and relevance for the course.

The students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of most of the present-day problems; and a sustained solution could emerge only through understanding of value-based living. Any solution brought out through fear, temptation of dogma will not be sustainable.

The students are able to see that verification on the basic of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions.

The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to overcome this disharmony.

The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facility in most of the cases, while they have given higher priority to earning of physical facility in their life giving less value to or even ignoring relationships and not being aware that right understanding is the most important requirement for any human being.

Module 2 – Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
> **Lecture 7:** Understanding Human being as the Co-existence of the Self and the Body
> **Lecture 8:** Distinguishing between the Needs of the Self and the Body

Tutorial 4: Practice Session PS4   Exploring the difference of Needs of Self and Body

Lecture 9: The Body as an Instrument of the Self

Lecture 10: Understanding Harmony in the Self

Tutorial 5: Practice Session PS5   Exploring Sources of Imagination in the Self

Lecture 11: Harmony of the Self with the Body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS6   Exploring Harmony of Self with the Body

Expected outcome:

The students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and Body are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too.

The students are able to see that all physical facility they are required for a limited time in a limited quantity. Also, they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.

The students are able to see that activities like understanding, desire, though and selection are the activities of 'I' only the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body.

The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance

The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.

Module 3 – Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7   Exploring the Feeling of Trust

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

Expected outcome:

The students are able to note that the natural acceptance (intention) is always for living in harmony, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.

The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for them and for others through he may have different body, physical facility or beliefs.

The students are able to use their creativity for education children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model.

Module 4 – Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

  Lecture 19: Understanding Harmony in the Nature
  Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
  Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
  Lecture 21: Realizing Existence as Co-existence at All Levels
  Lecture 22: The Holistic Perception of Harmony in Existence
  Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence

Expected outcome:

The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human being s are not fulfilling to other orders today and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and right utilization) in the nature.

The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also, they are able to make out how these courses can be made appropriate and holistic.

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

  Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Expected outcome:
The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.
The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. E.g. mutually enriching production system with rest of nature.
The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for the happy and prosperous family and society.

Guidelines and Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education
PS1   Sharing about Oneself
PS2   Exploring Human Consciousness
PS3   Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being
PS4   Exploring the difference of Needs of Self and Body
PS5   Exploring Sources of Imagination in the Self
PS6   Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society
PS7   Exploring the Feeling of Trust
PS8   Exploring the Feeling of Respect
PS9   Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)
PS10   Exploring the Four Orders of Nature
PS11   Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12   Exploring Ethical Human Conduct
PS13   Exploring Humanistic Models in Education
PS14   Exploring Steps of Transition towards Universal Human Order

As an example, PS 7 is a practice session in module 3 regarding trust. It is explained below:

PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

1a. Do I want to make myself happy?	1b. Am I able to make myself always happy?
2a. Do I want to make the other happy?	2b. Am I able to make the other always happy?
3a. Does the other want to make him happy?	3b. Is the other able to make him always happy?
4a. Does the other want to make me happy?	4b. Is the other able to make me always happy?
Intention (Natural Acceptance)	Competence
What is the answer?	What is the answer?

Let each student answer the questions for himself/herself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention and competence as well as the others' intention and competence.

Expected outcome of PS 7: The students are able to see that the first four questions are related to our Natural Acceptance i.e. intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention, as a result we conclude that I am a good person and other is a bad person.

3- READINGS:

3-1-Text Book and Teachers Manual

a. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53

c. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

3-2-Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, 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 – Pandit Sunderlal
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)

4- MODE OF CONDUCT (L-T-P-C 2-1-0-3)

Lecture 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.

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

5- SUGGESTED 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.

6- 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.
Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1. Holistic vision of life
2. Socially responsible behaviour
3. Environmentally responsible work
4. Ethical human conduct
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

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.

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Course Code	:	AU- 02
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
  - o Meaning & definition of Physical Education
  - o Aims & Objectives of Physical Education
  - o Changing trends in Physical Education

Module II: Olympic Movement
  - o Ancient & Modern Olympics (Summer & Winter)
  - o Olympic Symbols, Ideals, Objectives & Values
  - o 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
  - o Meaning & Importance of Physical Fitness & Wellness
  - o Components of Physical fitness
  - o Components of Health related fitness
  - o Components of wellness
  - o Preventing Health Threats through Lifestyle Change
  - o Concept of Positive Lifestyle

Module IV: Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga
  - o Define Anatomy, Physiology & Its Importance
  - o Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

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

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

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

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

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

Module X: Psychology & Sports
- o Definition & Importance of Psychology in Physical Edu. & Sports

- o Define & Differentiate Between Growth & Development
- o Adolescent Problems & Their Management
- o Emotion: Concept, Type & Controlling of emotions
- o Meaning, Concept & Types of Aggressions in Sports.
- o Psychological benefits of exercise.
- o Anxiety & Fear and its effects on Sports Performance.
- o Motivation, its type & techniques.
- o Understanding Stress & Coping Strategies.

Module XI: Doping
- o Meaning and Concept of Doping
- o Prohibited Substances & Methods
- o Side Effects of Prohibited Substances

Module XII: Sports Medicine
- o First Aid – Definition, Aims & Objectives.
- o Sports injuries: Classification, Causes & Prevention.
- o 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.
- o History of the Game/Sport.
- o Latest General Rules of the Game/Sport.
- o Specifications of Play Fields and Related Sports Equipment.
- o Important Tournaments and Venues.
- o Sports Personalities.
- o 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.

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HSMC (H-102)	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	2L:1T:0P	3 Credits

Pre-requisites: None. Universal Human Values 1 (Desirable)

1- COURSES ON HUMAN VALUES

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.

Objectives of UHV-II Course
This introductory course input is intended:
4. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
5. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
6. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Salient Features of the Course

The salient features of this course are:

5. It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.
6. The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.
7. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
8. While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology

7. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
8. The course is in the form of 28 lectures (discussions) and 14 practice sessions.
9. It is free from any dogma or value prescriptions.
10. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.
11. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.
12. This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

2- COURSE TOPICS

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 01-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

The syllabus for the lectures and practice sessions is given below:

Module 1 – Introduction to Value Education (6 lectures and 3 tutorials for practice session)

> **Lecture 1:** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
> **Lecture 2:** Understanding Value Education
> **Tutorial 1**: **Practice Session PS1**   Sharing about Oneself
> **Lecture 3:** Self-exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2   Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3   Exploring Natural Acceptance

Expected outcome:
The students start exploring themselves: get comfortable with each other and with the teacher; they start appreciating the need and relevance for the course.
The students start finding that technical education without study of human values can generate more problems than solutions. They also start feeling that lack of understanding of human values is the root cause of most of the present-day problems; and a sustained solution could emerge only through understanding of value-based living. Any solution brought out through fear, temptation of dogma will not be sustainable.

The students are able to see that verification on the basic of natural acceptance and experiential validation through living is the only way to verify right or wrong, and referring to any external source like text or instrument or any other person cannot enable them to verify with authenticity; it will only develop assumptions.
The students are able to see that their practice in living is not in harmony with their natural acceptance most of the time, and all they need to do is to refer to their natural acceptance to overcome this disharmony.
The students are able to see that lack of right understanding leading to lack of relationship is the major cause of problems in their family and not the lack of physical facility in most of the cases, while they have given higher priority to earning of physical facility in their life giving less value to or even ignoring relationships and not being aware that right understanding is the most important requirement for any human being.

Module 2 – Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
Lecture 7: Understanding Human being as the Co-existence of the Self and the Body
Lecture 8: Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session PS4   Exploring the difference of Needs of Self and Body
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session PS5   Exploring Sources of Imagination in the Self
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6   Exploring Harmony of Self with the Body

Expected outcome:

The students are able to see that they can enlist their desires and the desires are not vague. Also they are able to relate their desires to 'I' and 'Body' distinctly. If any desire appears related to both, they are able to see that the feeling is related to I while the physical facility is related to the body. They are also able to see that 'I' and Body are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centered on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too.

The students are able to see that all physical facility they are required for a limited time in a limited quantity. Also, they are able to see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.

The students are able to see that activities like understanding, desire, though and selection are the activities of 'I' only the activities like breathing, palpitation of different parts of the body are fully the activities of the body with the acceptance of 'I' while the activities they do with their sense organs like hearing through ears, seeing through eyes, sensing through touch, tasting through tongue and smelling through nose or the activities they do with their work organs like hands, legs etc. are such activities that require the participation of both 'I' and body.

The students become aware of their activities of 'I' and start finding their focus of attention at different moments. Also they are able to see that most of their desires are coming from outside (through preconditioning or sensation) and are not based on their natural acceptance

The students are able to list down activities related to proper upkeep of the body and practice them in their daily routine. They are also able to appreciate the plants wildly growing in and around the campus which can be beneficial in curing different diseases.

Module 3 – Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

> **Lecture 13:** Harmony in the Family – the Basic Unit of Human Interaction
> **Lecture 14:** 'Trust' – the Foundational Value in Relationship
> **Tutorial 7: Practice Session PS7** Exploring the Feeling of Trust
> **Lecture 15:** 'Respect' – as the Right Evaluation
> **Tutorial 8: Practice Session PS8** Exploring the Feeling of Respect
> **Lecture 16:** Other Feelings, Justice in Human-to-Human Relationship
> **Lecture 17:** Understanding Harmony in the Society
> **Lecture 18:** Vision for the Universal Human Order
> **Tutorial 9: Practice Session PS9** Exploring Systems to fulfil Human Goal

Expected outcome:

The students are able to note that the natural acceptance (intention) is always for living in harmony, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention as a result we conclude that I am a good person and other is a bad person.

The students are able to see that respect is right evaluation, and only right evaluation leads to fulfilment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms and so on so forth. All these problems can be solved by realizing that the other is like me as he has the same natural acceptance, potential and program to ensure a happy and prosperous life for them and for others through he may have different body, physical facility or beliefs.

The students are able to use their creativity for education children. The students are able to see that they can play a role in providing value education for children. They are able to put in simple words the issues that are essential to understand for children and comprehensible to them. The students are able to develop an outline of holistic model for social science and compare it with the existing model.

Module 4 – Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

      Lecture 19: Understanding Harmony in the Nature
      Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
      Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
      Lecture 21: Realizing Existence as Co-existence at All Levels
      Lecture 22: The Holistic Perception of Harmony in Existence
      Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence

Expected outcome:

The students are able to differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them. They are also able to see that human being s are not fulfilling to other orders today and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and right utilization) in the nature.

The students feel confident that they can understand the whole existence; nothing is a mystery in this existence. They are also able to see the interconnectedness in the nature, and point out how different courses of study relate to the different units and levels. Also, they are able to make out how these courses can be made appropriate and holistic.

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

      Lecture 23: Natural Acceptance of Human Values
      Lecture 24: Definitiveness of (Ethical) Human Conduct
      Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
      Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
      Lecture 26: Competence in Professional Ethics
      Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
      Lecture 27: Holistic Technologies, Production Systems and Management Models- Typical Case Studies

> **Lecture 28:** Strategies for Transition towards Value-based Life and Profession
> **Tutorial 14: Practice Session PS14** Exploring Steps of Transition towards Universal Human Order

Expected outcome:

The students are able to present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.

The students are able to grasp the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. E.g. mutually enriching production system with rest of nature.

The students are able to sincerely evaluate the course and share with their friends. They are also able to suggest measures to make the course more effective and relevant. They are also able to make use of their understanding in the course for the happy and prosperous family and society.

Guidelines and Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education
PS1   Sharing about Oneself
PS2   Exploring Human Consciousness
PS3   Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being
PS4   Exploring the difference of Needs of Self and Body
PS5   Exploring Sources of Imagination in the Self
PS6   Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society
PS7   Exploring the Feeling of Trust
PS8   Exploring the Feeling of Respect
PS9   Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)
PS10   Exploring the Four Orders of Nature
PS11   Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12   Exploring Ethical Human Conduct
PS13   Exploring Humanistic Models in Education

PS14   Exploring Steps of Transition towards Universal Human Order

As an example, PS 7 is a practice session in module 3 regarding trust. It is explained below:
PS 7: Form small groups in the class and in that group initiate dialogue and ask the eight questions related to trust. The eight questions are:

1a. Do I want to make myself happy?	1b. Am I able to make myself always happy?
2a. Do I want to make the other happy?	2b. Am I able to make the other always happy?
3a. Does the other want to make him happy?	3b. Is the other able to make him always happy?
4a. Does the other want to make me happy?	4b. Is the other able to make me always happy?
Intention (Natural Acceptance)	Competence
What is the answer?	What is the answer?

Let each student answer the questions for himself/herself and everyone else. Discuss the difference between intention and competence. Observe whether you evaluate your intention and competence as well as the others' intention and competence.

Expected outcome of PS 7: The students are able to see that the first four questions are related to our Natural Acceptance i.e. intention and the next four to our Competence. They are able to note that the intention is always correct, only competence is lacking! We generally evaluate ourselves on the basis of our intention and others on the basis of their competence! We seldom look at our competence and others' intention, as a result we conclude that I am a good person and other is a bad person.

3- READINGS:

3-1-Text Book and Teachers Manual

a. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53

c. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022.

3-2-Reference Books

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, 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 – Pandit Sunderlal
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)

4- MODE OF CONDUCT (L-T-P-C 2-1-0-3)

Lecture 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.

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

5- SUGGESTED 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.

6- 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.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

7. Holistic vision of life

8. Socially responsible behaviour

9. Environmentally responsible work

10. Ethical human conduct

11. Having Competence and Capabilities for Maintaining Health and Hygiene

12. Appreciation and aspiration for excellence (merit) and gratitude for all

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.

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SEMESTER – III

EC-01	Electronic Devices	3L:0T:0P	3 Credits

Course Contents:

Introduction to Semiconductor Physics: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors

Generation and recombination of carriers; Poisson and continuity equation P-N junction characteristics , I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode

Bipolar Junction Transistor, I-V characteristics, Ebers Moll Model, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor;LED, photodiode and solar cell;

Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

Text /Reference Books
1. G. Streetman, and S. K. Banerjee, Solid State Electronic Devices, 7th edition, Pearson,2014.
2. Donald Neamen , Dhrubes Biswas "Semiconductor Physics and Devices" McGraw-Hill Education
3. S. M. Sze and K. N. Kwok, Physics of Semiconductor Devices, 3rd edition, John Wiley &Sons, 2006.
4. C.T. Sah, Fundamentals of solid state electronics, World Scientific Publishing Co Inc, 1991.
5. Y. Tsividis and M. Colin, Operation and Modeling of the MOS Transistor. Oxford Univ. Press, 2011.
6. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
7. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Understand the principles of semiconductor Physics and apply it to electronic devices
2. Appreciate different devices for different applications.
3. Understand and utilize the mathematical models of semiconductor devices for circuits.
4. Understand the basic processes required for fabrication of electronic devices.

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EC02: Electronic Devices Lab
Hands on experiments related to the course contents EC01

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EC-03	Digital System Design	3L:0T:0P	3 Credits

Course Contents:

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion.

MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU

Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation

Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices.

VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation

VHDL constructs and codes for combinational and sequential circuits.

Text/Reference Books:
1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill.
2. R. Anand, Digital System Design Using VHDL, Khanna Book Publishing Company.
3. R. Anand, Digital Electronics, Khanna Book Publishing Company.
4. Douglas Perry, "VHDL", Tata McGraw Hill.
5. Gothman, "Digital Electronics-An introduction to theory and practice", Pearson Education
6. Douglas-Hall, "Digital Circuits and Systems", Tata McGraw Hill
7. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Understand the basic logic operations and combinational logic elements.
2. Design and analyze combinational circuits
3. Design and analyze synchronous sequential logic circuits
4. Use HDL and appropriate EDA tool for digital logic design and simulation
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EC04: Digital System Design Laboratory
Hands on experiments related to the course contents EC03
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| EC-05 | Signals and System | 3L:0T:0P | 3 Credits |

Course Contents:

An introduction to signals and systems- Signals and systems as seen in everyday life, and in various branches of engineering and science electrical, mechanical, hydraulic, thermal, biomedical signals and systems as examples. Extracting the common essence and requirements of signal and system

Formalizing signals- energy and power signals, signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. Formalizing systems- system properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.

Continuous time and discrete time Linear shift-invariant (LSI) systems in detail-the impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.

Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and Orthogonal bases of signals.

The Laplace Transform for continuous time signals and systems- the notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. Generalization of Parseval's Theorem. The z-Transform for discrete time signals and systems- eigen functions, region of convergence, system functions, poles and zeros of systems and sequences, z-domain analysis. Generalization of Parseval's Theorem.

System realization through block-diagram representation and system interconnection. State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Applications of signal and system theory- modulation for communication, filtering and so on. Advanced topics: time-frequency representation and the uncertainty principle, Short-time Fourier Transforms and wavelet transforms.

Text/Reference books:

1. R. Anand, Signals and Systems, Khanna Publishing House, 2019.
2. A.V. Oppenheim, A.S. Willsky and I.T. Young,"Signals and Systems", Prentice Hall, 1983.
3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
4. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
5. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
6. Douglas K. Lindner, "Introduction to Signals and Systems", Mc-Graw Hill International Edition: c1999.
7. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Identify the sources of signals, and systems in real life.
2. Characterize different types of signals and systems.
3. Represent continuous-time and discrete-time systems in different mathematical forms.
4. Analyze system behavior using time and frequency domain techniques.

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EC-05	Network Theory	3L:0T:0P	3 Credits

Course Contents:

Node and Mesh Analysis: Kirchoff's laws, Node and mesh equations, Matrix approach of complicated network containing voltage and current sources, and reactances, source transformation and duality.

Network theorem: Superposition, Reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.

Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalance circuit and power calculation.

Laplace transforms and properties: Partial fraction, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace

transforms evaluation of initial conditions. Two port network and interconnections, Behaviors of series and parallel resonant circuits. Introduction to filters.

Transient behavior, concept of complex frequency, Driving points and transfer functions, Poles and zeros of immittance function, their properties, Sinusoidal response from pole-zero integral solutions.

Text/Reference Books

1. Van, Valkenburg.; "Network analysis"; Prentice hall of India, 2000
2. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata Mcgraw-Hill New Delhi, 1994
3. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze the circuit using Kirchhoff's law and Network simplification theorems
2. Infer and evaluate Transient response and Steady state response of a network
3. Analyze electrical networks in the Laplace domain and understand concept of network functions and stability.
4. Compute the parameters of a two-port network.

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EC-06	Network Theory	3L:0T:0P	3 Credits

Course Contents:

Node and Mesh Analysis, matrix approach of network containing voltage and current sources, and reactances, source transformation and duality. Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits. Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.

Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Text/Reference Books

1. Van, Valkenburg.; "Network analysis"; Prentice hall of India, 2000
2. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi,1994
3. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education
4. Ashfaq Husain, Networks and Systems, Khanna Book Publishing, 2021.

Course Outcomes:
At the end of this course students will demonstrate the ability to
1. Understand basics electrical circuits with nodal and mesh analysis.
2. Appreciate electrical network theorems.
3. Apply Laplace Transform for steady state and transient analysis.
4. Determine different network functions.
5. Appreciate the frequency domain techniques.

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EC-07	**Probability Theory and Stochastic Processes**	**2L:1T:0P**	**3 Credits**

Course Content:
Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.
 Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;
Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;
Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.
Random process. Stationary processes. Mean and covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density.

Text/Reference Books:
1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing,'' Third Edition, Pearson Education
2. A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes,'' Fourth Edition, McGraw Hill.
3. K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International
4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability, UBS Publishers,
5. S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Develop understanding of basics of probability theory.
2. Identify different distribution functions and their relevance.
3. Apply the concepts of probability theory to different problems.
4. Extract parameters of a stochastic process and use them for process characterization.

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SEMESTER – IV

EC-08	Analog circuits	3L:0T:0P	3 Credits

Course Contents:

Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.

High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.

Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators.

Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.

OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines.

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.

Text/Reference Books:
1. A.V.N. Tilak, Design of Analog Circuits, Khanna Publishing House, 2022.
2. J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
3. P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, Edition IV
5. Paul R.Gray & Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley, 3rd Edition

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

1. Understand different circuit configuration of different devices for various applications.
2. Design circuits by using appropriate device models
3. Design various analog circuits required in electronic systems.
4. Design mixed circuits such as ADC and DACs

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EC09: Analog Circuit Laboratory
Hands on experiments related to the course contents EC08

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EC-08	Microcontrollers	3L:0T:0P	3 Credits

Course Contents:

Overview of microcomputer systems and their building blocks, memory interfacing, concepts of interrupts and Direct Memory Access, instruction sets of microprocessors (with examples of 8085 and 8086);

Interfacing with peripherals - timer, serial I/O, parallel I/O, A/D and D/A converters; Arithmetic Coprocessors; System level interfacing design;

Concepts of virtual memory, Cache memory, Advanced coprocessor Architectures- 286, 486, Pentium; Microcontrollers: 8051 systems,

Introduction to RISC processors; ARM microcontrollers interface designs.

Text/Reference Books:

1. R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996
2. D A Patterson and J H Hennessy, "Computer Organization and Design The hardware and software interface. Morgan Kaufman Publishers.
3. Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill, 1991.
4. Kenneth J.Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Understand the architecture of microprocessors and microcontrollers
2. Develop programs for various microcontrollers.
3. Interface various peripherals with microcontrollers and programs it for various systems
4. Design and implement real-life engineering applications.

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EC11: Microcontrollers Lab
Hands on experiments related to the course contents EC10
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EC-12	Analog and Digital Communication	3L:0T:0P	3 Credits

Course Contents:

Review of signals and systems, Frequency domain of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter Symbol Interference and Nyquist criterion.

Bandpass Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

Information Measures: Discrete Source models – Memoryless and Stationary, Mutual Information, Self-Information, Conditional Information, Average Mutual Information, Entropy, Entropy of the block, Conditional Entropy, Information Measures for Analog Sources.

Text/Reference Books:

1. B.P.Lathi,Zhi Ding "Modern Digital and Analog Communication", Oxford, 4th Edition,2011
2. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
3. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
4. Taub H. and Schilling D.L., "Principles of Communication Systems",Tata McGraw Hill, 2001.
5. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.
6. R. Anand, Communication Systems, Khanna Book Publishing Company, 2011.

Course Outcomes:

At the end of this course, the students should be able to
1. Illustrate the principles of amplitude and angle modulation techniques
2. Analyze the performance of waveform coding techniques.
3. Compare bandpass digital modulation techniques for bit error rate, bandwidth and power requirements
4. Understand the concept of information rate and channel capacity.

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EC13: Analog and Digital Communication Laboratory
Hands on experiments related to the course contents EC12

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ES-06	Numerical Techniques	2L:0T:2P	3 Credits

Course Contents:

Interpolation by polynomials, error of the interpolating polynomial, piecewise linear and cubic spline interpolation.

Numerical integration, Simpson rule, composite rules, error formulae, Gauss quadrature.

Solution of a system of linear equations, implementation of Gaussian elimination and Gauss-Seidel methods, partial pivoting, row echelon form, LU factorization, Cholesky's method, ill-conditioning, norms.

Solution of a nonlinear equation, bisection and secant methods. Newton-Raphson method, rate of convergence, solution of a system of nonlinear equations.

Numerical solution of ordinary differential equations, Euler and Runge-Kutta methods, multistep methods, predictor-corrector methods, order of convergence, finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations.

Eigenvalue problem, power method, QR method, Gershgorin's theorem. Exposure to software packages like MATLAB.

Text/Reference Books:

1. S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980.
2. C. E. Froberg, Introduction to Numerical Analysis (2nd Edition), Addison-Wesley, 1981.
3. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
4. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing (2022).
5. K. E. Atkinson, An Introduction to Numerical Analysis (2nd edition), Wiley-India, 1989
6. R. Agor, Elements of Mathematical Analysis, Khanna Publishing House, 2015.

Course Outcomes:
At the end of this course students will demonstrate the ability to
1. Understand different numerical integration techniques, and numerically solve differential equations.
2. Perform various matrix computations and solve simultaneous linear equations.
3. Find roots of a transcendental equation using different methods.
4. Implement different interpolation schemes.

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SEMESTER - V

EC-14	Digital Signal Processing	3L:1T:0P	4 Credits

Course Contents:

Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; Discrete systems attributes, Z-Transform, Analysis of LSI systems, frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems

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

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

 Application of DSP to Speech and Radar signal processing.

Text/Reference Books:
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.

Course Outcomes:
At the end of this course students will demonstrate the ability to
1. Interpret and analyze discrete time signals.
2. Compute Discrete Fourier Transform and appreciate the importance of Fast Fourier Transform
3. Design IIR and FIR filters.
4. Apply signal processing algorithms for real time applications.

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EC15: Digital Signal Processing Laboratory

Hands on experiments related to the course contents EC14

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EC-16	**Electromagnetic Waves**	3L:1T:0P	4 Credits

Course Contents:

Transmission Lines- Equations of Voltage and Current on TX line, Propagation constant, Characteristic impedance and reflection coefficient, Impedance Transformation, Loss-less and Low Loss Transmission line and VSWR, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines, Impedance Matching, Lossy transmission line, Problems on Transmission line, Types of transmission line.

Maxwell's Equations- Basics of Vectors, Vector calculus, Basic laws of Electromagnetics, Maxwell's Equations, Boundary conditions at Media Interface.

Uniform Plane Wave- Uniform plane wave, Propagation of wave, Wave polarization, Pioncere's Sphere, Wave propagation in conducting medium, Wave propagation and phase velocity, Power flow and Poynting vector, Surface current and power loss in a conductor

Plane Waves at a Media Interface- Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction at media interface, Total internal reflection, Polarization at media interface, Reflection from a conducting boundary.

Waveguides- Parallel plane waveguide,Wave propagation in parallel plane waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization and Attenuation in waveguide, Attenuation in waveguide continued.

Radiation- Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz, dipole, thin linear antenna, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna, Fourier transform relation between current and radiation pattern.

Text/Reference Books:

1. R.K. Shevgaonkar, „Electromagnetic Waves, Tata McGraw Hill India, 2005
2. R.L. Yadav, Electromagnetic Fields and Waves, Khanna Book Publishing, 2021
3. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
4. Narayana Rao, N: Engineering Electromagnetics, 3rd ed., Prentice Hall, 1997.
5. David Cheng, Electromagnetics, Prentice Hall

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Appreciate the importance of transmission lines and analyze transmission line problems like impedance transformation and matching using analytical and graphical methods.
2. Solve Maxwell's equations to understand propagation of electromagnetic waves in unbound medium and across media interfaces.
3. Analyze electromagnetic wave propagation in rectangular metallic waveguides and resonators.
4. Understand antenna characteristics, and design linear antennas and their arrays.

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EC17: Electromagnetic Waves Lab

Hands on experiments related to the course contents EC16

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EC-18	Computer Architecture	3L:0T:0P	3Credits

Course Contents:

Basic Structure of Computers, Functional units, software, performance issues software, machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, Assembly language, Stacks, Ques, Subroutines.

Processor organisation, Information representation, number formats.
multiplication & division ALU design, Floating Point arithmetic, IEEE 754 floating point formats

Control Design, Instruction sequencing, Interpretation, Hard wired control - Design methods, and CPU control unit. Microprogrammed Control - Basic concepts, minimizing microinstruction size, multiplier control unit. Microprogrammed computers - CPU control unit Memory organization, device characteristics, RAM, ROM, Memory management, Concept of Cache & associative memories, Virtual memory,.

System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfaces Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network

Text/Reference Books
1. V.Carl Hammacher, "Computer Organisation", Fifth Edition.
2. A.S.Tanenbum, "Structured Computer Organisation", PHI,Third edition
3. Y.Chu, "Computer Organisation and Microprogramming", II, Englewood Chiffs, N.J.,Prentice Hall,Edition
4. M.M.Mano, "Computer System Architecture", Edition
5. C.W.Gear, "Computer Organisation and Programming", McGraw Hill, N.V,Edition
6. Hayes J.P, "Computer Architecture and Organisation", PHI,Second edition
7. Ikvinderpal Singh, "Computer Organisation and Architecture", Khanna Book Publishing.

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

1. Analyze the computing systems and their development processes
2. Analyze the performance of computers and the role of software and hardware in it.
3. Interface memory and I/O devices to CPU to make a complete system.
4. Understand the architecture of modern CPUs and issues related to them such as Cache memories, out of order instruction execution etc.

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EC-19	Control Systems	3L:0T:0P	3Credits

Course Contents:

Introduction to control problem: Industrial Control examples, Transfer function models of mechanical, electrical, thermal and hydraulic systems, System with dead-time, System response, Control hardware and their models: potentiometers, synchros, 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, transfer function.

Basic characteristics of feedback control systems: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. Basic modes of feedback control: proportional, integral and derivative. Feed-forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion. 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.

Frequency-response analysis: Relationship between time & frequency response, Polar plots, Bode's 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.

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, tracking problem, Nonlinear system: Basic concept & analysis.

Text/Reference Books:
1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Ambikapathy A., Control Systems, Khanna Book Publications, 2019.
3. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
4. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
5. Nagrath & Gopal, "Modern Control Engineering", New Age International, New Delhi

Course Outcomes: At the end of this course students will demonstrate the ability to
1. Understand the concepts of control systems and importance of feedback in control systems.
2. Perform computations and solve problems on frequency response analysis.
3. Evaluate different types of state models and time functions.
4. Analyse different types of control systems like linear and non-linear control systems, etc.

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EC-20	Embedded systems	3L:0T:0P	3Credits

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 tradeoffs 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 Microcomputor System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 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.

Course Outcome:
At the end of this course students will demonstrate the ability to
1. Understand advanced concepts of Embedded System Architecture
2. Design systems for various embedded applications.
3. Design software systems such as RTOS using embedded controllers.
4. Analyze Hardware Software co-design trade-offs

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EC21: Embedded systems Lab
Hands on experiments related to the course contents EC20

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SEMESTER – VI

EC-22	Computer Networks	3L:0T:0P	3Credits

Course Contents:

Introduction to computer networks and Internet: Introduction to Data Network and ISO-OSI protocol, Fundamentals of Physical Layer and different modes of data communication.

Link layer: ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing, Ethernet, Hubs, Switches.

Switching in networks: Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Crossbar switch and evaluation of blocking probability, 2-stage, 3-stage and n-stage networks, Packet switching, Blocking in packet switches, Three generations of packet switches, switch fabric, Buffering, Multicasting, Statistical Multiplexing.

Network layer: Virtual circuit and Datagram networks, Router, Internet Protocol, Routing algorithms, Broadcast and Multicast routing.

Transport layer: Connectionless transport - User Datagram Protocol, Connection-oriented transport – Transmission Control Protocol, Remote Procedure Call.
Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.

Application layer: Principles of network applications, The Web and Hyper Text Transfer Protocol, File transfer, Electronic mail, Domain name system, Peer-to-Peer file sharing, Socket programming, Layering concepts.

Text Reference books:
1. Andrew Tanenbaum, "Computer networks", Prentice Hall
2. B. A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 4th Edition
3. J.F. Kurose and K. W. Ross, "Computer Networking – A top down approach featuring the Internet", Pearson Education, 5th Edition
4. Bhavneet Sidhu, An Integrated Approach to Computer Networks, Khanna Publications.
5. T. Viswanathan, "Telecommunication Switching System and Networks", Prentice Hall
6. D. Comer, "Computer Networks and Internet/TCP-IP", Prentice Hall
7. William Stallings, "Data and computer communications", Prentice Hall

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand data communication and the functions of each layer of ISO-OSI protocols.
2. Perform computations and solve networking and routing problems.
3. Find differences between Real time and Non Real time protocols using different techniques.
4. Implement small connections between two or more processes running in single or different computing systems.

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EC23: Computer Network Laboratory

Hands on experiments related to the course contents EC22

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EC-24	VLSI Design	3L:0T:0P	3Credits

Course Contents:

Introduction to VLSI; CMOS Logic: Combinational and sequential circuits, CMOS fabrication and layouts, Layout representations, Stick diagrams, Design partitioning, Logic design, Circuit design, Physical design, Design verification, fabrication, packaging and testing, Design Flow.

Modeling of MOS transistor, Capacitance voltage characteristics, non-ideal effects DC transfer characteristics, MOS Inverter, MOS Transistor Switches, CMOS Logic design, Circuit and System Representations, Design Equations, Static Load MOS Inverters, Transistor Sizing, Static and Switching Characteristics; Body Effect, Noise Margin;

Delay and Power
Transient Response, RC Delay Model, Effective Resistance, Gate and Diffusion Capacitance, Equivalent RC Circuits, Transient Response, Elmore Delay, Layout Dependence of Capacitance, Determining Effective Resistance, Linear Delay Model Logical Effort, Parasitic Delay, Delay in a Logic Gate, Drive, Extracting Logical Effort from Datasheets, Limitations to the Linear Delay Model, Logical Effort of Paths, Delay in Multistage Logic Networks, Choosing the Best Number of Stages, Sources of power dissipation, dynamic power , static power, Wire Geometry, Example of Metal Stacks, Interconnect Modelling, Resistance, Capacitance Inductance, Skin Effect, Temperature Dependence, Interconnect Impact, Delay, Energy, Crosstalk, Inductive Effects,

Circuit Design
Circuit Families, Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass-Transistor Circuits, Sequencing Static Circuits, Sequencing Methods, Max-Delay Constraints, Min-Delay Constraints, Time Borrowing, Clock Skew, Circuit Design of Latches and Flip-Flops, Conventional CMOS Latches, Conventional CMOS Flip-Flops, Pulsed Latches, Resettable Latches and Flip-Flops, Enabled Latches and Flip-Flops, Incorporating Logic into Latches

Subsystems Design
Adders, zero one detectors, comparators, counters, Memory subsystems SRAM, Read and write operation, DRAM, sense amplifiers

Text Book:

1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.

Reference Books

1. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley,1979.
2. S. M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, MH, 2002
3. J. M. Rabaey, A. P. Chandrakasan and B. Nikolic, Digital Integrated Circuits : A Design Perspective, Second Edition, PHI /Pearson, 2003.
4. J. P. Uyemura, CMOS Logic Circuit Design, Springer; 2001,.
5. J. P. Uyemura, Introduction to VLSI Circuits and System, Wiley, 2002.
6. R. J. Baker, H. W. Li and D. E. Boyce, CMOS Circuit Design, Layout and Simulation, PH, 1997.

Course Outcomes
At the end of this course students will demonstrate the ability to
1. Understand the models of MOS transistors and its use in circuit simulations.
2. Illustrate the use of various delay models and optimize the CMOS circuit delay.
3. Understand the effects of interconnects on the circuit performance
4. Design and analyze various CMOS combinational and sequential circuits, data path and memory subsystems.

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EC25: VLSI Design Laboratory
Hands on experiments related to the course contents EC24

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EC-26	Mobile Communication and Networks	3L:0T:0P	3Credits

Course Contents:

Cellular concepts- Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G 3G, 4G and 5G cellular mobile standards.

Signal propagation- Propagation mechanism, reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small-scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels. Antennas: antennas for mobile terminal, monopole antennas, PIFA, base station antennas and arrays.

Multiple access schemes-FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity Altamonte scheme.

MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average snr, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA, 3G, 4G and 5G mobile communications.

Text/ Reference Books

1. Erik Dahlman , 4G, LTE-Advanced Pro and The Road to 5G
2. Sassan Ahmadi, 5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards Hardcover – 1 June 2019
3. Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann, Reprinted 2012.
4. Vijay K. Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, Fifth Impression 2008
5. T.S.Rappaport, "Wireless Communications Principles and Practice", PHI, II Edition, 2006.
6. William Lee ,"Mobile Cellular Telecommunications: Analog and Digital Systems", McGraw Hill Education

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand cellular concepts and signal propagation in mobile communication.
2. Perform small simulations and plot results on modulation techniques.
3. Analysis performance of different generations of mobile communications.
4. Solve numerical problems on different multi-access and modulation schemes of mobile communications.

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APPENDIX

Appendix-I

Program Elective Courses

ECEL01: Microwave Theory and Techniques

Course Contents:

Introduction to Microwaves-History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC.

Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.

Analysis of RF and Microwave Transmission Lines- Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Micro strip line.

Microwave Network Analysis- Equivalent voltages and currents for non-TEM lines, Network parameters for microwave circuits, Scattering Parameters.

Passive and Active Microwave Devices- Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron.

Microwave Design Principles- Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design. Microwave Antennas- Antenna parameters, Antenna for ground based systems, Antennas for airborne and satellite borne systems, Planar Antennas.

Microwave Measurements- Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters.

Microwave Systems- Radar, Terrestrial and Satellite Communication, Radio Aids to Navigation, RFID, GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.

Text/Reference Books:

1. 1.R.E. Collins, Microwave Circuits, McGraw Hill
2. 2.K.C. Gupta and I.J. Bahl, Microwave Circuits, Artech house
3. Kulkarni M, "Microwave and Radar Engineering", 4th Edition, Umesh Publications, 2012.
4. G.S. Raghuvanshi "Microwave Engineering" , Cengage Learning, New Delhi,2012.
5. Samuel Y. Liao, "Microwave Devices and Circuits", 3rd Edition, Pearson Education, 2003.
6. David M. Pozar , Microwave Engineering, 4th Edition, Wiley India, 2012.

Course Outcomes:

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

1. Develop mathematical models for transmission lines and waveguides.
2. Understand functioning of Passive and Active microwave devices.
3. Design basic microwave circuits and do microwave measurements.
4. Understand and analyze microwave systems for different applications.

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ECEL02: Fiber Optic Communication

Course Contents:

Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model.

Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.

Optical sources - LEDs and Lasers, Photo-detectors - pin-detectors, detector responsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.

Optical switches - coupled mode analysis of directional couplers, electro-optic switches.

Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and solition based communication. Optical amplifiers - EDFA, Raman amplifier, Coherent communication and WDM systems.

Text/Reference Books
1. J. Keiser, Fibre Optic communication, McGraw-Hill, 2nd Ed. 1992.
2. John M Senior," Optical Fiber Communications Principles and Practice", Pearson 3rd Edition
3. J.E. Midwinter, Optical fibers for transmission, John Wiley, 1979.
4. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
5. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1992

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Understand different models of light and their limitations.
2. Understand propagation of light in different types of optical fibers and signal degradation.
3. Design analog and digital optical communication links and analyze their performance.
4. Understand, analyze and design high-capacity advanced optical communication systems.

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ECEL03: Information Theory and Coding

Course Contents:

Basics of information theory: Entropy for discrete ensembles; Shannon's noiseless coding theorem; Encoding of discrete sources. Markov sources, Shannon's noisy coding theorem and converse for discrete channels, Calculation of channel capacity and bounds for discrete channels, application to continuous channels.

Techniques of coding and decoding: Channel Coding, Block and convolutional codes; majority logic decoding; Viterbi decoding algorithm, Coding gains and performance. Huffman codes and uniquely detectable codes; Cyclic codes, convolutional arithmetic codes.

Network Information Theory: Overview of multiple access channel (MAC), Achievable result for MAC using successive decoding technique, Outer bound on the capacity region of MAC and its capacity analysis, Gaussian MAC and its capacity analysis.

Introduction to broadcast channel: Superposition coding scheme and its optimality for the degraded broadcast channel, Relation between the capacity region of Gaussian BC and MAC. Achievable rate for interference limited networks using conventional techniques such as time-sharing and treating interference as noise.

Introduction to channel coding for multi users: Introduction, Block codes for the binary adder channel, Trellis codes for the multiple access channel.

Text/Reference Books:

1. N. Abramson, Information and Coding, McGraw Hill, 1963.
2. M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987.
3. R.B. Ash, Information Theory, Prentice Hall, 1970.
4. Shu Lin and D.J. Costello Jr., Error Control Coding, Prentice Hall, 1983.
5. A. El Gamal and Y. H. Kim, Network Information Theory, Cambridge University Press, 2011

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand the basics of Information theory, techniques of coding and decoding.
2. Analyze and compare different coding and decoding schemesEvaluate
3. Solve numerical problems on channel capacity and coding.
4. Evaluate and case study broadcast channels for different coding schemes and also multiuser channel coding.

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ECEL04: Digital Audio Processing

Course Contents:

Audio Signal Characteristics, Production model, Hearing and Auditory model, Acoustic characteristic of speech, Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model

Audio signal acquisition, Representation and Modelling, Enhancement of audio signals: Spectral Subtraction, Weiner based filtering, Neural nets

Audio/ Speech Analysis and Synthesis Systems: Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction., Linear Predictive Coding Analysis.

Psychoacoustics, Multi-microphone audio processing: Room acoustics, Array beamforming. Acoustic sound source localization and tracking

Applications: Principles of Automatic Speech Recognition (ASR),Theory and implementation of Hidden Markov Model (HMM) for ASR, Speaker Recognition, Evolution of Speech APIs, Natural Language Processing, Sound source separation models.

Text/References:

1. Sen, Soumya, Dutta, Anjan Dey, Nilanjan, Audio Processing and Speech Recognition,1st edition, 2019, Springer
2. Gold, B.; Morgan, N.; Ellis, D. Speech and audio signal processing: processing and perception of speech and music. 2nd rev. ed. Wiley-Blackwell, 2011.
3. Bali & Bali, Audio Video Systems, Khanna Book Publishing.
4. Sadaoki Furui, "Digital Speech Processing, Synthesis and Recognition" 2/e.
5. Rabiner and Schafer, "Digital Processing of Speech Signals", Pearson Education

Course Outcomes:

At the end of this course, the students should be able to
1. Understand different characteristics of Audio signals.
2. Analyze different speech analysis and synthesis systems.
3. Write an algorithm for automatic speech recognition system
4. Design models and algorithms for audio and speech processing applications.

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ECEL05: Introduction to MEMS

Course Contents:

Introduction and Historical Background , Scaling Effects. Micro/Nano Sensors, Actuators and Systems overview: Case studies. Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA), Etching. Micromachining: Surface Micromachining, sacrificial layer processes, Stiction; Bulk
Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding.Mechanics of solids in MEMS/NEMS: Stresses, Strain, Hookes's law, Poisson effect, Linear
Thermal Expansion, Bending; Energy methods, Overview of Finite Element Method, Modeling of Coupled Electromechanical Systems.

Text/Reference Book:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and
2. Smart Systems, Wiley India, 2012.
3. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and
4. Microengineering (Vol. 8). CRC press, (2005).
5. S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
6. M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.
7. G. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, Boston, 1998.
8. M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and
9. gyroscopes, Elsevier, New York, 2000.

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand the multidisciplinary aspects of MEMS and NEMS and their applications
2. Understand the methods of fabrication and modeling methods.
3. Appreciate the underlying working principles of MEMS and NEMS devices
4. Design and model these devices

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ECEL06: Adaptive Signal Processing

Course Contents:

General concept of adaptive filtering and estimation: applications and motivation, Review of probability, random variables and stationary random processes, Correlation structures, properties of correlation matrices.

Adaptive Filters: Optimal FIR (Wiener) filter, Method of steepest descent, extension to complex valued LMS algorithm (real, complex), convergence analysis, weight error correlation matrix, excess mean square error and mis-adjustment, variants of the LMS algorithm: the sign LMS family, normalized LMS algorithm, block LMS and FFT based realization, frequency domain adaptive filters, Sub-band adaptive filtering.

Signal space concepts: introduction to finite dimensional vector space theory, subspace, basis, dimension, linear operators, rank and nullity, inner product space, orthogonality, Gram-Schmidt orthogonalization, concepts of orthogonal projection, orthogonal decomposition of vector spaces, vector space of random variables, correlation as inner product, forward and backward projections, Stochastic lattice filters, recursive updating of forward and backward prediction errors, relationship with AR modeling, joint process estimator, gradient adaptive lattice.

RLS: Introduction to recursive least squares (RLS), vector space formulation of RLS estimation, pseudo-inverse of a matrix, time updating of inner products, development of RLS lattice filters, RLS transversal adaptive filters.

Advanced topics : affine projection and sub-spaced based adaptive filters, partial update algorithms, QR decomposition and systolic array.

Text/Reference Books:

1. S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
2. Bernard Widrow and Samuel D. Stearns, Adaptive signal processing, Prentice Hall, 1984.
3. by Tulay Adali and Simon Haykin, Adaptive Signal Processing: Next Generation Solutions; Pub: Wiley

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the general concepts of adaptive filtering and estimation.
2. Analyze different types of adaptive filters used in signal processing.
3. Solve numerical problems on correlation, convergence and filtering aspects.
4. Evaluate and compare different adaptive signal processing techniques.

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ECEL07: Antennas and Propagation

Course Contents:

Fundamental Concepts- Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.

Radiation from Wires and Loops- Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.

Aperture and Reflector Antennas- Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.

Broadband Antennas- Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.

Micro strip Antennas- Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Antenna Arrays- Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.

Basic Concepts of Smart Antennas- Concept and benefits of smart antennas, Fixed weight beamforming basics, Adaptive beamforming.

Different modes of Radio Wave propagation used in current practice.

Text/Reference Books:
1. J.D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.
3. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
4. R.C. Johnson and H. Jasik, Antenna Engineering Handbook,cGraw ill, 1984.
5. I.J. Bahl and P. Bhartia, Micro Strip Antennas, Artech House,1980.
6. R.K. Shevgaonkar, Electromagnetic Waves, TataMcGraw Hill, 2005
7. R.E. Crompton, Adaptive Antennas, John Wiley

Course outcomes:
At the end of this course students will demonstrate the ability to
1. Understand antenna characteristics for different applications.
2. Analyze and design different types of antennas.
3. Design antenna arrays and understand operation of smart antennas.
4. Investigate different modes of propagation and their suitability for wireless communication.

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ECEL08: Bio-Medical Electronics

Cell structure, basic cell functions, origin of biopotentials, electrical activity of cells, Acquisition, types of bio-signals, Study of diagnostically significant bio-signal parameters, Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface Cardio-vascular system and measurements: Structure of heart, rhythmicity, pacemaker cell filters, averaging and integrator circuits, ECG signal acquisition, ECG electrodes, electrocardiograph, vector cardiograph, ECG analysis, ECG- QRS detection, R amplitude, interval detection, Bio-signal amplifiers and signal processing, transient protection, isolation circuit, Phonocardiography, PCG analysis to diagnose heart valve disorder, blood pressure measurement (invasive and non-invasive), blood flow meter-magnetic and ultrasound, cardiac output measurement, Plethysmography, Short wave diathermy, microwave diathermy, ultrasound therapy unit, transcutaneous electrical nerve stimulators, radiotherapy, Pacemakers and defibrillators, heart lung machine.

Central nervous systems and muscular system: Receptors, sensory pathways and motor systems, processing sensory information, neural, neuromuscular, sensory muscular and sensory measurements, biofeedback, evoked response, Electroencephalography (EEG), EEG amplifier, separation of alpha, beta, theta and delta waves from EEG. Classification of muscles – muscle contraction mechanism, myoelectric voltages, Electromyography (EMG), noise removal and signal compensation for reducing ECG artifacts in an EMG recording.

Auditory and vision system: Mechanism of hearing, sound conduction system, basic audiometer, pure tone audiometer, Evoked response audiometer system, hearing aids.

Anatomy of eye, visual acuity, slit lamp, tonometer, ophthalmoscope, perimeter, LASER applications in ophthalmology – diabetic retinopathy, glaucoma and retinal hole and detachment treatment.

Introduction to image processing. Imaging systems X-rays, image intensifiers, CT scanner, ultrasound scanner, nuclear methods, thermography, MRI, fusion imaging

Text /Reference books:

1. Leslie Cromwell, Fred J. Weibull, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd edition, 1980.
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", TMH, 2nd edition, 2000
3. Vander, Shermen, "Human Physiology– The Mechanism of Body Functions", TMH, 13th edition, 2013.
4. Tompkins, "Biomedical Digital Signal Processing", PHI, 5th edition, 2010.

Course Outcomes:

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

1. Explain the origin of biopotentials and various electrodes for sensing and conditioning bio signals.
2. Analyze the human cardio- vascular, central nervous and muscular system and explain the different measurement techniques for the signals originating from these systems.
3. Apply image processing principles in imaging techniques such as X-rays, image intensifiers, CT scanners, ultrasound scanners and MRI.
4. Select suitable transducers for medical applications.

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ECEL09: Advanced Mobile Communications

Course Contents:

Mobile Communications Overview: Evolution from 1G to 5G, Analog voice systems in 1G, digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G (EDGE); IMT2000, 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates, IMT Advanced, 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+), IMT2020, enhancements in comparison to IMT Advanced.

Introduction to 5G Communication: 5G potential and applications, Usage scenarios, enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications, Spectrum for 5G, spectrum access/sharing, millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity.

5G Network: New Radio (NR), Standalone and non-standalone mode, non-orthogonal multiple access (NOMA), massive MIMO, beam formation, PHY API Specification, flexible frame structure, Service Data Adaptation Protocol (SDAP), centralized RAN, open RAN, multi-access edge computing (MEC); Introduction to software defined networking (SDN), network function virtualization (NFV), network slicing; restful API for service-based interface, private networks.

Current state and Challenges ahead: 5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements, large cell usage, LMLC, possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul / backhaul solutions: LEOs, HAP/UAV.

Text and References Books:
1. Mobile Communications by Jochen Schiller Pub: Financial Times / Imprint of Pearson
2. Mobile Cellular Telecommunications: Analog and Digital Systems by William Lee, Pub: McGraw Hill Education
3. Mobile Communications Design Fundamentals by William Lee, Pub: Wiley India Pvt. Ltd.
4. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the evolution of mobile communication standards developed over the years.
2. Perform computations and solve numerical problems on different frequency division multiple access techniques.
3. Assess how softwarization of network functions helps in scalability and ease of operations.
4. Evaluate the use of advanced techniques in cellular communications.

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ECEL10: Digital Image Processing

Course Contents:

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Color Image Processing-Color models – RGB, YUV, HSI; Color transformations – formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation.

Image Segmentation- Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation.

Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Subband filter banks, wavelet packets.

Image Compression-Redundancy – inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.

Fundamentals of Video Coding- Inter-frame redundancy, motion estimation techniques – full-search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X.

Video Segmentation- Temporal segmentation – shot boundary detection, hard-cuts and soft-cuts; Spatial segmentation – motion-based; Video object detection and tracking.

Text/Reference Books:

1. R.C.Gonzalez and R.E. Woods, "Digital Image Processing", Second Edition, Pearson Education.
2. Anil Kumar Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India.
3. Murat Tekalp, "Video Processing".

Course outcomes: At the end of this course students will demonstrate the ability to
1. Understand fundamentals of digital image processing and representation of images in spatial and transform domain.
2. Apply image enhancement restoration techniques for improving quality of images.
3. Develop algorithms for image compression, coding, and segmentation.
4. Apply multi-resolution techniques for image processing.

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ECEL11: Mixed Signal Design

Course Contents:

Analog and discrete-time signal processing, introduction to sampling theory; Analog continuous-time filters: passive and active filters; Basics of analog discrete-time filters and Z-transform.

Switched-capacitor filters- Nonidealities in switched-capacitor filters; Switched-capacitor filter architectures; Switched-capacitor filter applications.

Basics of data converters; Successive approximation ADCs, Dual slope ADCs, Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs.

Mixed-signal layout, Interconnects and data transmission; Voltage-mode signaling and data transmission; Current-mode signaling and data transmission.

Introduction to frequency synthesizers and synchronization; Basics of PLL, Analog PLLs; Digital PLLs; DLLs.

Text /References:

1. R.Jacob Baker, "CMOS Mixed Signal Circuit Design", Wiley India, IEEE Press, reprint 2008.
2. R.Jacob Baker,"CMOS Circuit Design, Layout and Simulation", Wiley India, IEEE Press, Second Edition, reprint 2009.
3. Behzad Razavi,"Design of Analog CMOS Integrated Circuits" McGraw Hill, 33rd Reprint, 2016.

Course Outcome:

At the end of this course students will demonstrate the ability to
1. Understand the concepts for mixed signal circuits.
2. Analyze the characteristics of IC based CMOS filters.
3. Design of various data converter architecture circuits.
4. Analyze the signal to noise ratio and modeling of mixed signals.

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ECEL12: Wireless Sensor Networks

Course Contents:

Introduction to Sensor Networks: unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks, Localization and tracking of objects.

Mobile Adhoc Networks (MANETs): Multi-hop networks and its advantages, Introduction to routing in ad hoc multi-hop networks, Applications of MANET.

Enabling technologies for Wireless Sensor Networks: Issues and challenges in wireless sensor networks, routing protocols in sensor networks, energy aware schemes, etc.

MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee,

Dissemination protocol for large sensor network: Data dissemination, data aggregation, data accumulation and data fusion; Quality of a sensor network; Real-time traffic support and security protocols, Data

Design Principles for WSNs: Gateway Concepts Need for gateway, WSN to Internet Communication, Internet to WSN Communication.

Architecture: Single-node architecture, Hardware components & design constraints, operating systems and execution environments, introduction to TinyOS and nesC.

Text Reference Books:

1. Waltenegus Dargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", By John Wiley & Sons Publications
2. Sabrie Soloman, "SENSORS" HANDBOOK by Mc Graw Hill publication.
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Elsevier Publications.
4. Kazem Sohrby, Daniel Minoli, "Wireless Sensor Networks": Technology, Protocols and Applications, Wiley-Inderscience
5. Philip Levis, And David Gay Tinyos "Programming" by Cambridge University Press

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

1. Understand principles of sensor networks and its difference with mobile ad hoc networks.
2. Evaluate computations related to energy saving using different routing schemes.
3. Analyze different MAC protocols used for different communication standards in WSN.
4. Design small sensor networks for different applications.

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ECEL13: Power Electronics

Course Contents:

Characteristics of Semiconductor Power Devices: Thyristor, power MOSFET and IGBT-Treatment should consist of structure, Characteristics, operation, ratings, protections and thermal considerations. Brief introduction to power devices viz. TRIAC, MOS controlled thyristor (MCT), Power Integrated Circuit (PIC) (Smart Power), Triggering/Driver, commutation and snubber circuits for thyristor, power MOSFETs and IGBTs (discrete and IC based).Concept of fast recovery and schottky diodes as freewheeling and feedback diode.Standard Driver Circuit Schematics for MoSFETs and IGBTs.

Controlled Rectifiers: Single phase: Study of semi and full bridge converters for R, RL, RLE and level loads. Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Effect of source impedance, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor.

Choppers: Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, Control techniques for choppers – TRC and CLC, Detailed analysis of Type A chopper. Step up chopper. Multiphase Chopper

Single-phase inverters: Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Filters at the output of inverters, Single phase current source inverter

Switching Power Supplies: Analysis of fly back, forward converters for SMPS, Resonant converters - need, concept of soft switching, switching trajectory and SOAR, Load resonant converter - series loaded half bridge DC-DC converter.

Applications: Power line disturbances, EMI/EMC, power conditioners. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings, sizing of UPS. Separately excited DC motor drive. P M Stepper motor Drive.

Text /Reference Books:
1) P.S. Bimbhra, Power Electronics, Khanna Book Publishing, 2022.
2) M Singh, K Khanchandani, "Power Electronics" McGraw Hill Education, 2nd Ed., 2017
3) Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
4) Ned Mohan, Robbins, "Power electronics", edition III, John Wiley and sons.
5) P.C. Sen., "Modern Power Electronics", edition II, S.Chand & Co.
6) V.R.Moorthi, "Power Electronics", Oxford University Press.
7) Cyril W., Lander," Power Electronics", edition III,McGraw Hill.
8) G K Dubey,S R Doradla,:Thyristorised Power Controllers",New Age International Publishers. SCR manual from GE, USA.

WebLinks:
1. .https://www.st.com/resource/en/application_note/cd00003900-drive-circuits-for-power-mosfets-

2. https://www.ti.com/lit/ml/slua618a/slua618a.pdf?ts=1673408094214&ref_url=https%253A%2
52F%252Fwww.google.com%252F

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Learn how to analyze inverters and some basic applications.
2. Analyze and design SMPS, controlled rectifiers DC to DC converters. and, DC to AC inverters.
3. Learn and design DC to AC inverters, Charge controllers
4. Analyze typical industrial application requirements and build a solution with commercially available power electronic devices.

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ECEL14: Satellite Communication

Course Contents:

Introduction to Satellite Communication: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication. IRNSS-NAVIC: Navigation with Indian Constellation

Orbital Mechanics: Orbital equations, Kepler"s laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.

Satellite sub-systems: Study of Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems etc

Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Satellite link budget
Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.

Modulation and Multiple Access Schemes:Various modulation schemes used in satellite communication, Meaning of Multiple Access, Multiple access schemes based on time, frequency, and code sharing namely TDMA, FDMA and CDMA.

Text /Reference Books:

1. Timothy Pratt and Jeremy Allnutt: "Satellite Communications": Ed 3, 2021.Wiley India.
2. Dennis Roddy: Satellite Communication: 4th Edition, McGraw Hill, 2001
3. Varsha Agrawal, Anil K. Maini, "Satellite Communications" Wiley India 2010.
4. Tri T. Ha: Digital Satellite Communications: Tata McGraw Hill.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the sub-systems of satellite communication systems and ground stations.
2. Understand the signal power calculation and issues in communication satellite tracking.
3. Compute parameters of orbital motions and understand communication with non-geosynchronous satellite
4. Understand different modulation types and interfacing the modems in satellite receivers.

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ECEL15: High Speed Electronics

Course Contents:

Transmission line theory (basics) crosstalk and non ideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, methodologies for design of high speed buses; radiated emissions and minimizing system noise;

Noise Analysis: Sources, Noise Figure, Gain compression, Harmonic distortion, Inter modulation, Cross-modulation, Dynamic range

Devices: Passive and active, Lumped passive devices(models), Active(models, low vs high frequency)

RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed)

Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages

Mixers –Up conversion Down conversion, Conversion gain and spurious response. Oscillators Principles.PLL Transceiver architectures

Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Microvia Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.

Text/Reference Books:

1. Stephen H. Hall, Garrett W. Hall, James A. McCall "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", August 2000, Wiley-IEEE Press
2. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 2004, ISBN 0521835399.
3. Behzad Razavi, "RF Microelectronics", Prentice-Hall 1998, ISBN 0-13-887571-5.
4. Guillermo Gonzalez, "Microwave Transistor Amplifiers", 2nd Edition, Prentice Hall.
5. Kai Chang,"RF and Microwave Wireless systems", Wiley.
6. R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011

Course Outcome:

At the end of this course students will demonstrate the ability to
1. Understand the concepts of high speed data communication.
2. Understand the methodologies for design of high speed buses.
3. Analyze the effect of noise on the performance of the high speed circuits.
4. Design of printed circuit board which can handle high speed power transfer.

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ECEL16: Nanoelectronics

Course Contents:

Introduction to nanotechnology, meso structures , Basics of Quantum Mechanics: Schrodinger equation, Density of States.Particle in a box Concepts, Degeneracy.Band Theory of Solids. Kronig-Penny Model. Brillouin Zones.

Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.),

Resonant Tunneling Diode, Single electron transistors, Carbon nano tube electronics, Band structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation

Text/ Reference Books

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nano electronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nano systems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press,1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. To get introduced to Nanoelectronics and nanotechnology.
2. Understand working of Nano scale devices such as transistors.
3. Understand modeling aspects of Nanoscale devices from the perspective of circuit applications.
4. Design of Carbon based Nanoelectronic devices

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ECEL17: Data Structures

Course Contents:

Introduction and Elementary Data Structures Introduction: Introduction to Data Structures and data types, Efficient use of memory, Recursion, time and space complexity of algorithms, Big O Notation and theta notations. Elementary Data Structures: Stacks, queues, Infix, Postfix & Prefix conversions, evaluations of expressions, multiple, stacks and queues, priority queues as heaps, double ended queue, implementation of stacks and queues

Linked Lists Singly linked lists, linked stacks and queues, polynomial addition, sparse matrices, doubly linked lists and dynamic storage management, circular linked list, Applications of Stacks, Queues and Linked lists, Garbage collection, Josephus Problem

Trees Basic terminology, binary trees, binary tree traversal, representations of binary tree, application of trees, decision tree, game trees, Threaded Trees, Binary Search Tree, AVL tree, B-tree

Graph Theory Graph representations, Graph Traversals, Dijkstra's algorithm for shortest path, Prim's and Kruskal's Algorithm for Minimal Spanning tree Module 5: Sorting and Searching Searching: Linear search, binary search and hash search. Sorting: Insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, and Bucket sort

Text Books/Suggested References:

1. Data Structures, R.S. Salaria, Khanna Book Publishing, 2019.
2. Data Structures and Program Design in C By Robert L. Kruse,C.L. Tondo, Bruce Leung, Pearson Education, 2007.
3. Expert Data Structures with C/ 3rd Edition, R.B. Patel, Khanna Book Publishing, 2020.
4. Expert Data Structures with C++/ 2nd Edition, R.B. Patel, Khanna Book Publishing, 2020.
5. Data Structures Using C & C++, By Langsam, Augenstein, Tanenbaum, Pearson Education, 1989.
6. Fundamentals of Data Structures, By Ellis Horowitz and Sartaj Sahni, Computer Science Press, 2011.
7. An introduction to data structures with applications, By J.P. Trembley & P.G. Sorensen, TMH, 2004.

Course outcomes:

After completion of course, students would be able to:

1. Understand the different types of data structure to be implemented using any programming language.
2. Choose the data structures that effectively model the information in a problem and analyses the efficiency trade-offs (run time and memory usage) among alternative data structure implementations or combinations.
3. Design, implement, test, and debug programs using a variety of data structures including stacks, queues, hash tables, binary and general tree structures, search trees, and graphs.
4. Apply efficient data structure (linked lists, stacks and queues) to solve a particular problem.

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ECEL17: Internet of Things

Course Contents:

IoT Introduction and Fundamentals: Deciphering the term IoT Applications where IoT can be deployed Benefits/Challenges of deploying an IoT, IoT components: Digital Signal Processing, Data transmission, Choice of channel (wired/wireless), back-end data analysis. Understanding packaging and power constraints for IoT implementation.

Signals, Sensors, Actuators, Interfaces : Introduction to sensors & transducers, Introduction to electrodes & biosensors, Static and dynamic characteristics of sensors, Different types of sensors, Selection criteria's for sensors / transducers, Signal conditioning modules of IoT system , Energy and power considerations, Introduction to actuators, Different types of actuators, Interfacing challenges, Modules of data acquisition system, Wireless sensor node structure, positioning topologies for IoT infrastructure.

Communication and Networking in IoT: Review of Communication Networks, Challenges in Networking of IoT Nodes, range, bandwidth Machine-to-Machine (M2M) and IoT Technology Fundamentals, Medium Access Control (MAC) Protocols for M2M Communications Standards for the IoT Basics of 5G Cellular Networks and 5G IoT Communications, Low-Power Wide Area networks (LPWAN)Wireless communication for IoT: channel models, power budgets, data rates.Networking and communication aspects: IPv6, 6LoWPAN, COAP, MQTT, Operating Systems need and requirements for IoT.

Modern networking: Cloud computing: Introduction to the Cloud Computing, History of cloud computing, Cloud service options, Cloud Deployment models, Business concerns in the cloud, Hypervisors, Comparison of Cloud providers, Cloud and Fog Ecosystem for IoT Review of architecture

IoT Data analytics and Security: OLAP and OLTP, NoSQL databases, Row and column Oriented databases, Introduction to Columnar DBMS CStore , Run :Length and Bit vector Encoding, IoT Data Analytics. Cryptographic algorithms, Analysis of Light weight Cryptographic solutions IoT security, Key exchange using Elliptical Curve Cryptography, Comparative analysis of Cryptographic Library for IoT.

IoT Applications:IoT applications like Home Automation, Precision Agriculture, Smart vehicles, Smart Grid, Industry 5.0.

Text/Reference Books

1. Arshdeep Bahga and Vijay Madisetti , "Internet of Things, a hands on approach" , Universities Press (India) Pvt. Ltd. 2017.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms"Copyright © 2016 Elsevier Inc.
3. William Stallings, " Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" Publisher: Addison-Wesley 2015

Course Outcomes:

At the end of the course, students will demonstrate the ability to
1. Illustrate the fundamentals of IoT
2. Identify suitable hardware and interfaces for IoT deployments.
3. Develop cloud computing model and service options.
4. Illustrate data analytics and security for IoT.

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ECEL19: Cyber Security

Course Contents:

Cyber Security Concepts: Cyber Risks, Breaches, attacks, Exploits, Social Engineering, Foot Printing, Scanning, etc.

Cryptography and Cryptanalysis: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security.

Infrastructure and Network Security: Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Introduction to Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management,

Cyber Security Vulnerabilities & Safe Guards: Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness.

Malware: Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.

Security in Evolving Technology: Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security. Basic security for HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.

LIST OF SUGGESTED BOOKS

1. Jeeva Jose & Vijo Mathew, Introduction to Security of Cyber-Physical Systems, Khanna Book Publishing Company, 2023.
2. William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.
3. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
4. Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
5. Atul Kahate, "Cryptography and Network Security", McGraw Hill.
6. V.K. Pachghare, "Cryptography and Information Security", PHI Learning

Reference Websites:

http://www.ignou.ac.in/upload/Announcement/programmedetails.pdf

Course Outcomes:

At the end of this course students will demonstrate the ability to
1. Understand the basic concept of cyber security and its importance.
2. Analyze and distinguish various security threats and attacks that are prevalent now.
3. Find different ways for safety of assets and systems by increasing the strength of security parameters.
4. Perform simple simulations of cyber security attacks and ways to mitigate those.

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ECEL20: Machine Learning

Course Contents:

Introduction to probability and linear algebra: Review of Probability Theory and Linear algebra, Convex Optimization, relationship between AI, ML, and DL

Introduction to Statistical Decision Theory, Regression: Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Logistic Regression, Partial Least Squares Classification: Linear Classification, LDA

Introduction to Perceptron and SVM, Neural Networks: Introduction, Early Models, Perceptron Learning, Back-propagation, Initialization of neural network, Training and Validation, Parameter Estimation

Introduction to Bayesian Learning, Bayes theorem, Bayes theorem and concept learning, Maximum Likelihood and least squared error hypotheses, maximum likelihood hypotheses for predicting probabilities, minimum description length principle, Bayes optimal classifier, Gibs algorithm, Naive Bayes classifier

Decision Trees - Stopping Criterion and Pruning, Loss function, Categorical Attributes, Multiway Splits, Missing values, Instability, Regression Trees. Bootstrapping and Cross Validation, Class Evaluation, Measures, ROC curve, MDL, Ensemble methods, Committee Machines and Stacking.

Partitional clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Density-Based Clustering, Gaussian Mixture Models, Expectation Maximization, Learning Theory, Re-enforcement Learning

Text/Reference Books:
1. Rajiv Chopra, Machine Learning, Khanna Book Publishing Company, 2023.
2. Hastie, T. R. Tibshirani, and J. G. Friedman, "The Elements of Statistical Learning: Data Mining, Inference and Prediction", New York, NY: Springer,
3. EthemAlpaydin, "Introduction to Machine Learning", PHI, 2005.
4. Bishop Christopher, "Neural Networks for Pattern Recognition", New York, NY: Oxford University Press,
5. Mitchell Tom, "Machine learning", New York, NY: McGraw-Hill,
6. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani "Introduction to Statistical Learning", Springer, 2013.

Course Outcomes: At the end of this course, the students should be able to
1. Grasp and develop algorithms for linear, logistic, and multivariate regression.
2. Design and implement linear and nonlinear classifiers based on SVM, Neural networks and Decision trees.
3. Identify and implement clustering techniques for moderate to large size data.
4. Evaluate and interpret the results of the machine learning algorithms.

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EC27 Seminar

Guidelines: Select a topic relevant to ECE domain and suitable for UG level presentation. For selection topics refer to internationally reputed journals. The primary reference should be published during the last two or three years. - Some of the journals/publications suitable for reference are: IEEE/the IET/IETE/Springer/Science Direct/ACM journals.

Course Outcomes:
At the end of the course, students will demonstrate the ability to:
1. Identify contemporary topics/concepts pertaining to recent trends in electronics and communication engineering and prepare documentation.
2. Present the selected topic with superiority demonstrating good communication skills.

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A. Project :

ECP1 Micro Project

Guidelines: The micro-project is a team activity having 3-4 students in a team. This is electronic circuit building and testing for developing real life small electronic applications. The micro-project may be a complete hardware or hardware with small programming aspect. It should encompass electronics components, devices, analog or digital ICs, micro controller etc. Micro-Project should cater to a small system required in laboratory or real-life application. Based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of Micro-project.

Course Outcomes:

At the end of the micro project, students will demonstrate the ability to:

1. Identify and define a problem statement from the requirements raised from literature survey /need analysis
2. Build and Test electronic circuits/prototype for developing real life small electronic applications.
3. Work in teams, write comprehensive report and effective presentation of the project work
4. Rapid prototyping which will lead them towards entrepreneurship.

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ECP2 Mini Project

Guidelines: The mini project is a team activity having 3-4 students in a team. This is electronic product design work with a focus on electronic circuit design. The mini project may be a complete hardware or a combination of hardware and software. Mini Project should cater to a small system required in laboratory or real life. It should encompass components, devices, analog or digital ICs, micro controllers with which functional familiarity is introduced. Based on comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of the mini project.

Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within the first week of the semester. The student is expected to exert on design, development, and testing of the proposed work as per the schedule.

Layout should be made using CAD based PCB simulation software. Due considerations should be given for power requirements of the system, mechanical aspects for enclosure and control panel design. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Course Outcomes:

At the end of the mini project work, students will demonstrate the ability to
1. Identify a problem statement either from a rigorous literature survey or the industry requirements analysis.
2. Design a solution for the identified problem by applying acquired technical knowledge.
3. Simulate, Develop and Test the Prototype with a standard solution/ process.
4. Learn to work in a team and coordinate within the group for timely completion of targeted work

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EC P3: Project

Guidelines: After interactions with project guides/industry experts, based on a comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of a project. The student is expected to work on details specifications, methodology, resources required, critical issues in design and implementation, and submit the project proposal within the first two weeks of semester.The student is expected to work on the design, development, and testing of the proposed project work as per the schedule. The project report is to be submitted at the end of the semester. This report includes a summary of the literature survey, detailed objectives, project specifications, design, proof of concept, developed system/Algorithm, results, contributions, and innovations in project work.

Course Outcomes:

At the end of the project work, students will demonstrate the ability to

1. Identify a problem statement from a rigorous literature survey or the industry requirements analysis.
2. Simulate and design a solution for the identified problem by applying acquired technical knowledge.
3. Develop and test the prototype/algorithm to solve the complex engineering problem.
4. Accomplish all objectives of the project in an allocated period with efficient teamwork.
5. Present project work orally and through a comprehensive report.

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Appendix – II

A Guide to Induction Program

Appendix – II: A Guide to Induction Program

Introduction

In its 49th meeting, held on 14th March 2017, AICTE approved a package of measures for further improving the quality of technical education in the country. This 3-week mandatory Student Induction Program (SIP) based on Universal Human Values (UHV) is one of these key measures.

The SIP is intended to prepare newly admitted undergraduate students for the new stage in their life by facilitating a smooth transition from their home and school environment into the college and university environment.

The present form of the Student Induction Program (SIP) has taken inspiration from and gratefully acknowledges the many efforts in this direction. In particular the Foundation Program at IIT Gandhinagar[1] (July 2011) and the course in Universal Human Values and Professional Ethics[2] (IIIT Hyderabad, 2005; AKTU Lucknow, 2009 and PTU Jalandhar, 2011; overall about 35 universities); and also, the mentorship, internship and apprenticeship programs[3] of several institutions. The SIP amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building a healthy lifestyle, 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 senior students as well as faculty members.

The purpose of this document along with accompanying details are to help institutions / colleges in understanding the spirit of the Induction Program and implementing it.

It is in line with the thoughts expressed in the NEP 2020:

"*Education is fundamental for achieving **full human potential**, developing an **equitable and just society**, and promoting **National development***".

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[1] IIT Gandhinagar places great emphasis on not only educating successful engineers of the future, but also creating well-rounded personalities, who contribute to society, are respectful of and can adapt to their surroundings, and prove themselves to be great thinkers and problem solvers in all avenues of life. In 2011, in line with this vision, It took the bold step to introduce a five week Foundation Program for incoming 1st year UG students. It involved activities such as games, art, etc.; also science and other creative workshops as well as lectures by eminent resource persons. To enable undivided attention on this, normal classes were scheduled only after this program was over.

[2] The foundation course was started in 2005 at IIIT Hyderabad. In 2009, UP Technical University (now AKTU) introduced it in all academic programs across their 550 colleges. From there on, it has been included in the curriculum of many universities, particularly in technical universities, in quite a natural manner, filling a long-felt need. After AKTU, it was IKG-Punjab Technical University in 2011, then Royal University of Bhutan in 2012 and so on. By 2020, more than 40 universities in India and both universities of Bhutan have been offering this foundation course. Since 2017, it has been a compulsory credit course in AICTE's model curriculum for all UG courses. Faculty from all departments are involved in conducting the course. The content is universal, rational, verifiable and leading to harmony. The mode is a self-exploration (and not sermonising or lecturing). Faculty are to be prepared beforehand. The results have been quite encouraging.

[3] Many institutes setup mentor-mentee network under which 1st year students are divided into small groups, each assigned to a senior student as a Student Buddy, and to a faculty member as a Faculty Mentor. Thus, a new student has their guidance through regular interactions. They can discuss their aims and aspirations as well as concerns whether social, psychological, financial, academic, or otherwise.

"The purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values".

"It aims at producing engaged, productive, and contributing citizens for building an equitable, inclusive, and plural society as envisaged by our Constitution".

"Education must build character, enable learners to be ethical, rational, compassionate, and caring, while at the same time prepare them for gainful, fulfilling employment".

"The curriculum must include basic arts, crafts, humanities, games, sports and fitness, languages, literature, culture, and values, in addition to science and mathematics, to develop all aspects and capabilities of learners; and make education more well-rounded, useful, and fulfilling to the learner".

So, when new students join an institution, they are to be welcomed and oriented to the institute, its vision, people, purpose, culture and values, policies, programs, rules and regulations etc. through a well-planned 3-week interaction before regular classes start.

Education aims at developing the students to their full potential, so that they are able to participate meaningfully not only in their profession, but also in their family, society and their natural environment. That requires the development of their values as well as skills.

Engineering colleges were established to train graduates in their respective branch/ department of study, be ready for the job market, but also have a holistic outlook towards life and have a desire and competence to work for national needs and beyond. The graduating student must have the knowledge and skills in the area of his study. However, s(he) must also have a broad understanding of society and relationships. Besides the above, several meta-skills and underlying values are needed. Character needs to be nurtured as an essential quality by which s(he) would understand and fulfil his/her responsibility as an engineer, a family member, a citizen etc.

The same applies to all other branches of study – be it professional, vocational or any other area of academic. The graduating student must be a good human being and have the skills in their area of study.

Each family, institution, region, community etc. have evolved their way of life, their cultures over a period of time. The new students are going from one culture to another. Today, a major issue is that one culture tends to be opposed to other cultures. This is because their basic assumptions, and therefore thoughts, are different. Even though there are commonalities at the core value level, the conflict is at the level of expression and details.

With this situation, it is imperative to
- Articulate the essence or core aspects of human culture and civilization, i.e. understand universal human values like trust and respect, love and compassion
- Appreciate the various expressions, different approaches taken in different regions

Our effort is in the context of the whole humanity. However, when it comes to exemplifying these essential concepts, we will have to take to local or national expressions.

In SIP, we want to provide an exposure to essence in the context of the whole humanity first. Then we can take a representative cross-section of all cultures as expressions of this essence. A yardstick to evaluate these various options is provided to guide the student towards a humanistic culture founded on the truth and universal human values like love and compassion.

For example: We want to live with fulfilment as a society. This part is common, universal. *To exemplify this, we may expose students to traditional Indian culture and philosophy as well as contemporary western culture and thought.*

The intent is:
- Connecting the basic principles through specific examples
- To see and appreciate various cultures, to see the commonality amongst them, in the light of clarity about human culture and civilisation.
- To evaluate any specific example, system or culture, with a view to fill the gaps, rather than to criticise or reject it. Further, we can also be mutually enriching for other cultures.

Student Induction Program (SIP)

With this background, the SIP has been formulated with specific goals to help students to:
- Become familiar with the ethos and culture of the institution (based on institutional culture and practices)
- Set a healthy daily routine, create bonding in batch as well as between faculty members and students
- Get an exposure to a holistic vision of life, develop awareness, sensitivity and understanding of the
  Self---family---Society---Nation---International---Entire Nature
- Facilitate them in creating new bonds with peers and seniors who accompany them through their college life and beyond
- Overcome weaknesses in some essential professional skills – only for those who need it (e.g. Mathematics, Language proficiency modules)

The SIP consists of different activities which includes meeting new students, socializing with teachers and other people in the university. Secondly associating with the Local area or city, knowing different departments, associating with the department heads, local stores and necessary shops for the survival at new place. Basically, getting information about the rules and regulations of the university which includes do's and don'ts. Other activities which may involve students in several creative, cultural and co- curricular activities through which they can explore themselves and get idea about their intrinsic desires and interests which may help them in the long run. In order to make it worth, at the initial level of joining of student various seminars, lectures by eminent personalities, sessions by the appointed mentor for the student is being done to make them more familiar with the university environment. It has been seen that student after schooling

when moves towards further studies for either under graduation or post-graduation has got so many confusions and false knowledge about the college and the curriculum. They should know the basic idea about the fruits and prospects of the particular course and the university or institute in which they are entering. To have faith about their choices and to know that after completion, they will be well equipped with the values and skills which may aid to their future goals and let them work for their personal motives, society and the Nation's development.

The various modules or core areas recommended for the 3-week SIP are:

SIP Module 1: Universal Human Values I (UHV I)   **22 hours**

The purpose is to help develop a holistic perspective about life. A self-reflective methodology of teaching is adopted. It opens the space for the student to explore his/her role (value) in all aspects of living – as an individual, as a member of a family, as a part of the society and as a unit in nature. Through this process of self-exploration, students are able to discover the values intrinsic in them. The session- wise topics are given below:

Session No.	Topic Title	Aspirations and Issues	Basic Realities (underlying harmony)
1	Welcome and Introductions	Getting to know each other	Self-exploration
2 and 3	Aspirations and Concerns	Individual academic, career… Expectations of family, peers, society, nation… Fixing one's goals	Basic human aspirations Need for a holistic perspective Role of UHV
4 and 5	Self-Management	Self-confidence, peer pressure, time management, anger, stress… Personality development, self-improvement…	Harmony in the human being
6 and 7	Health	Health issues, healthy diet, healthy lifestyle Hostel life	Harmony of the Self and Body Mental and physical health
8, 9, 10 and 11	Relationships	Home sickness, gratitude towards parents, teachers and others Ragging and interaction Competition and cooperation Peer pressure	Harmony in relationship Feelings of trust, respect… gratitude, glory, love
12	Society	Participation in society	Harmony in the society
13	Natural Environment	Participation in nature	Harmony in nature/existence
14	Sum Up	Review role of education	Information about UHV-II course,

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		Need for a holistic perspective	mentor and buddy
15	Self-evaluation and Closure	Sharing and feedback	

SIP Module 2: Physical Health and Related Activities   **51 hours**
This module is intended to help understand the basic principles to remain healthy and fit and practice them through a healthy routine which includes exercise, games etc.

SIP Module 3: Familiarization of Department/ Branch and Innovation 06 hours
This module is for introducing and relating the student to the institution/department/branch; how it plays a role in the development of the society, the state, region, nation and the world at large and how students can participate in it.

SIP Module 4: Visit to a Local Area   **10 hours**
To relate to the social environment of the educational institution as well as the area in which it is situated through interaction with the people, place, history, politics…

SIP Module 5: Lectures by Eminent People   **06 hours**
Listening to the life and times of eminent people from various fields like academics, industry etc. about careers, art, self-management and so on enriches the student's perspective and provides a holistic learning experience.

SIP Module 6: Proficiency Modules   **06 hours**
This module is to help fill the gaps in basic competency required for further inputs to be absorbed. It includes effort to make student proficient in interpersonal communication and expression as well as awareness about linguistic and thereafter NLP.

SIP Module 7: Literature / Literary Activities   **30 hours**
Through the exposure of local, national and international literature, this module is aimed at helping the student learn about traditional as well as contemporary values and thought.

SIP Module 8: Creative Practices   **49 hours**
This module is to help develop the clarity of humanistic culture and its creative, joyful expression through practice of art forms like dance, drama, music, painting, pottery, sculpture etc.

SIP Module 9: Extra Curricular Activities   **06 hours**
This is a category under which things that are not placed in any of the above may be placed. Some clubs and hobby group may be made for each of the above categories, so that students may pursue them even after SIP.

The recommended hours to be allocated are given above. Depending on the available faculty, staff, infrastructure, playgrounds, class timings, hostellers and day scholars etc., the timetable for these activities may be drawn up. Of course, colleges may conduct an

inaugural function at the beginning of the SIP; and they may also conduct a celebratory closing ceremony at the end of the SIP.

In particular, during the lockdown phase, appropriate care may be taken and some or all activities may be planned in distance-learning or on-line mode.

Sample 3-week Activity List

Week 1	Inaugural Function Regular SIP Activities (See Hours Plan)
Week 2	Regular SIP Activities (See Hours Plan)
Week 3	Regular SIP Activities (See Hours Plan) Valedictory and Closing Ceremony (Celebration)

Implementation

Every institution/college is expected to conduct the 3-week SIP under the guidance of the Director/Principal or Dean Students or a senior faculty member. For this, the institution is expected to make an SIP Cell / team, which will be responsible for planning, and then implementation of the SIP.

A UHV Cell is expected to be set up at each college and university. At the college, it will be managed by the UHV Convener / Coordinator under the chairpersonship of the director/principal. Faculty members and some students will be the members. They will coordinate the UHV activities like UHV-I during SIP, UHV-II, the faculty mentoring program and student buddy program throughout the student's association with the institute/college. The UHV Cell will work to incorporate human values in every aspect of education at the institute/college. Preparing UHV Faculty (Mentors) is one of its important activities.

Follow up

The SIP is only the beginning of the interaction with newly joined students.

An important part of the SIP is to associate one faculty mentor to every small groups of about 20 students; and also associate one senior student buddy to an even smaller groups of about 5 students for the guidance required for holistic development of the newly joined student throughout his/her time in the institution/college.

These activities are to be continued in the ongoing academic program along with other cultural activities through various student clubs which are largely be managed by students with the help of one or more faculty mentors. One of the main responsibilities of the faculty mentors would be helping the clubs to review their activities in alignment with human values.

Assessing the Implementation and Impact

The institution / college is expected to take feedback and prepare appropriate reports for assessing the impact and for further improvement of SIP. The basic feedback forms are included with the SIP Teaching Materials.

The SIP and its further follow up is expected to positively impact common graduate attributes like:

- Holistic vision of life
- Socially responsible behaviour
- Environmentally responsible work
- Ethical human conduct

Having Competence and Capabilities for Maintaining Health and Hygiene
Appreciation and aspiration for excellence (merit) and gratitude for all

AICTE will conduct periodic assessment to ascertain the implementation efforts and impact of the SIP and related activities.

Faculty Development

To ensure the implementation of SIP, and in particular to prepare the faculty, the National Coordination Committee for Student Induction (NCC-IP) has been formed. It offers various faculty development programs (FDPs) with the support from AICTE HQ and Regional Offices.

UHV Faculty (Mentors): Every institution is expected to prepare UHV Faculty in the ratio of 1:20 (1 faculty per 20 newly admitted students). Faculty from every teaching department are to be prepared. The basic preparation is participation in an 8-day FDP-SI (UHV).

Faculty for other Modules: Institutions/colleges generally have faculty, coaches, student clubs, alumni for these areas. FDP and comprehensive material will also be made available.

Student Activity Cell (SAC) – SIP Cell, UHV Cell and Fostering Unit

Student Activity Cell will have three cells or units:

- Fostering Unit – for coordinating various student clubs and activities in alignment with human values and IKS through various student clubs
- SIP Cell – for coordinating the annual SIP
- UHV Cell – for coordinating regular UHV activities, including UHV-I during SIP and UHV-II during future semesters, faculty mentoring and student buddy programs etc.
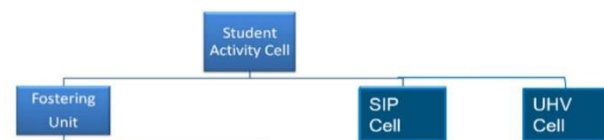
Each cell / unit will have some axis. E.g. the Fostering Unit will have 3 axis:

- UHV Axis – for UHV inputs and activities after the SIP
- Health Axis – for health oriented inputs and activities after SIP
- Career Axis – for career related inputs

Each axis will have one or more dimensions. E.g. the UHV Axis will have two dimensions:

- UHV Dimension
- Social Work Dimension

- Details of the clubs will be based on local conditions.

- Director or Principal or Dean of Student affairs will be the Chairman of Student Activity Cell

- SIP Cell (or Induction Unit) will be managed by faculty members with the help of student volunteers. 5 to 7 faculty members will be the members. The SIP Cell will be responsible for planning, organization, coordination and reporting of the annual Student Induction Program with the help of other faculty members and student volunteers

- UHV Cell will be managed by the UHV Convener / Coordinator under the chairpersonship of the director/principal. Faculty members and some students will be the members. They will coordinate the UHV activities like UHV-I during SIP, UHV-II 3rd/4th semester, faculty mentoring program and student buddy program throughout the student's association with the institute/college. UHV Cell will work to incorporate human values in every aspect of education at the institute/college. Preparing UHV Faculty (Mentors) is one of its activities

- Fostering unit will largely be managed by students with the help of one fostering unit faculty mentor. Student will be coordinators for axis, dimensions and clubs. Fostering unit will take support from induction unit as and when required. It will be responsible for coordinating various student clubs and activities in alignment with human values and Indian Knowledge System

SIP Teaching Material and More Details
The SIP Handbook as well as detailed guides and material for each of the modules is available on the AICTE website (http://www.fdp-si.aicte-india.org/download.php).

Details and Reference Documents:
- G012 SIP Handbook v2
- Teaching Material for UHV-I v2.1
- Teaching Material for SIP modules 2 to 9 v1
- G008 Facilitator (Mentor) Manual Version 2.1
- G911 UHV Cell, Nodal and Resource Centres
- G009 RP Development Process v2

SKILL BASED COURSES
[1ˢᵗ, 2ⁿᵈ , 3ʳᵈ and 4ᵗʰ Semester]

Sl no	Semester	Subject
1	1ˢᵗ	**Semiconductor Devices and Application**
2	2ⁿᵈ	**Repairing and maintenance of Domestic Electronics Appliances**
3	3ʳᵈ	**Embedded Design and Application**
4	4ᵗʰ	**PCB Design and Fabrication**

Embedded Design and Application

Module 1: Embedded System design: Basics
Introduction to embedded systems, Components of embedded system, Advantages and applications of embedded systems, Examples of real time embedded systems and how they are manufactured industry ready, Different Microcontroller Architectures (CISC, RISC, ARISC).
Internal Resources & Hardware Chips in Details, History of AVR Microcontrollers and Features.
Memory Architectures (RAM/ROM).

Module 2: Learning Arduino Platform
Introduction to ARDUINO, ARDUINO History and Family, Programming in Embedded-C, Concepts of C language, General Hardware Interfacings: LED's ,Switches, Seven Segment ,Display ,Multi Segment Displays ,Relays (AC Appliance Control) ,LCD ,Buzzer ,IR Sensors ,Other Digital Sensors .

Module 3:The basic sensors and actuators using Arduino
Introduction to sensors and actuators, How to connect and work with different sensors, such as Humidity, Proximity, IR Motion, Accelerometer, Sound, Light Distance, Pressure, Thermal etc. to ARDUINO Board, Reading various sensor data on serial monitor and LCD Display, Functioning of actuator

Module 4: Controlling embedded system based devices using Arduino
Reading data from analog and digital sensors on Serial Monitor/LCD Monitor, Work with LED Controlled by Switch/potentiometer, segment displays, How to connect relays and servomotors to ARDUINO Board, Work with 5V/3V Power supply using voltage regulator IC'S.

PCB DESIGN AND FABRICATION

Chapter No. 1- Introduction to Printed circuit board: Fundamental of electronic components, basic electronic circuits, Basics ofprinted circuitboarddesigning:Layoutplanning,generalrulesand parameters, groundconductorconsiderations,thermalissues,checkandinspectionof artwork.

Chapter No. 2- Design rules for PCB:Design rules for Digital circuit PCBs, Analog circuit PCBs,high frequency andfastpulseapplications,Powerelectronicapplications,Microwaveapplications.

Chapter No. 3- Introduction to Electronic design automation(EDA) tools for PCB designing: Brief Introduction of various simulators, SPICE and PSPICE Environment, Selecting the Components Footprints as per design, Making New Footprints, Assigning Footprint to components, Net listing, PCB Layout Designing, Auto routing and manual routing. Assigning specific text (silkscreen) to design, creating report of design, creating manufacturing data (GERBER) for design.

Chapter No. 4 –Introduction printed circuit board production techniques: Photo printing, film-masterproduction,reprographic camera,basic processfordouble sided PCBsphoto resists,Screenprinting process, plating,relative performance and quality control, etching machines, Solders alloys,fluxes,solderingtechniques,Mechanicaloperations. Demonstration

Chapter No. 5-PCB Technology Trends:Multilayer PCBs. Multi wire PCB, Flexible PCBs, Surface mount PCBs, Reflow soldering, Introduction to High-Density Interconnection (HDI) Technology.

COURSE TITLE: Repairing and Maintenance of Domestics Electronics Appliances

Module-1

Introduction to Electricity

• Electric Charge, Voltage, Electric Current • Ohm's Law, Electric Potential, Cell • Serial and Parallel Circuit, their effect on Voltage and Current • Transformer, Use and Operation

Module-2

Electronic and Electrical components

• Active and Passive Components • Resistors, Capacitors and Inductors, their identification, types and application • Semiconducting Devices: Diodes, its type, characteristics and applications • Transistors, Integrated Circuits • Study of a transistor, use of a transistor as an amplifier and as a switch. • Analog ICs, 555 timer, IC741, characteristics of 741 • Digital ICs, ICs for logic gates, Truth table verification of logic gates • Connectors • Fuse, types, Use of Fuses and its rating • Relays and Switches • Panel Components • Digital electronics – gates and its application, multiplexers, de-multiplexers, counter

Module-3

Soldering/ de- soldering techniques

• Soldering Iron, Soldering wire, Soldering Flux, Soldering method, Zero defect soldering • Desoldering pump, Temperature controlled soldering station, • Hands-on-practices of Soldering

Module-4

Tools and equipment use for Repairing and maintenance of Electrical Equipment

• Screw Driver Set • Tweezers, Different Types of Tweezers, Nose Pliers, Wire Cutter • Hot air gun • Liquid solder pest, Magnifying Lamp and Measuring Tools • Brush, CRO, Nipper • Test and Measurement Equipment, Multimeter Operation etc

Module-5

Basic functionality and Installation of washing machine

• Different type of washing machines & working principle, • Basic hand wash process, Different types of technologies being used in Washing machines – Pulsator, Agitator, Agipellar, Tumble wash, • Main parts of washing machines and their functionalities etc. • Opening the packed Washing machine, Selection of the suitable place for washing machine, • Installation of washing machine, • Demonstration of various functionality of washing machine

Module-6

Fault identification, Repair and Maintenance of Washing machine

• Testing & identification of the faulty block on the basis of symptom, rectifying common faults by replacing the damage components, • Testing of the damage block after repair, • Step by step re-assembly of the washing machine panel.

Module-7

Basic functionality and Installation of Microwave oven

• Basic working principle of circuit and block description of Microwave Oven/ Induction Stove • identification of parts and their working • MWO / Induction Stove heating/cooking, MWO/ Induction Stove safe utensils, Tips & Safety precautions for MW/ Induction Stove • Opening the packaged Microwave Oven/ Induction Stove • Selection of the electric power socket • switch rating and place for microwave oven/ Induction Stove installation • Install the microwave oven/ Induction Stove with the help of step by step instruction. • Demonstration of various functionality of Microwave Oven/ Induction Stove.

Module-8

Fault identification, Repair and Maintenance of Microwave oven and Induction Stove

• Identify the problem based on customer's information, possible solutions and repair costs involved, • Common occurring faults with the Microwave Oven/ Induction Stove their identification and repair. • Maintenance of Microwave Oven/ Induction Stove.

Module-9

Basic functionality and Installation of Mixer/Juicer/Grinder

• Working principle of mixer/juicer/grinder, • Identification of various parts and their functionalities. • functioning of motor and circuit breaker, • Opening the packaged Mixer/Juicer/Grinder, assembly of component, • Selection of the power socket, switch rating and place for installation, • Steps to Install the Mixer/Juicer/Grinder. Demonstration of various functionalities of Mixer/Juicer/Grinder

Module-10

Fault identification, Repair and Maintenance of Mixer/Juicer/Grinder

• Common occurring faults, identification and repair, • maintenance of Mixer/Juicer/Grinder

Module-11

Basic functionality and Installation of Water purifier

• Working principle /functionality of different types of water purifiers, part identification and their working, • unpacking of Water purifier, Selection of the place for installation, • Steps to Install the water purifier.

Module-12

Fault identification, Repair and Maintenance of Water purifier

• Identification of problem, possible causes and solution • Replacement of parts • Water Filter Maintenance

Module-13

Safety and Security Procedures

• Reporting incidents, system failures, power failures etc., protection equipment • First aid requirement in case of electrical shocks and other injuries

Semiconductor Devices and Application

Module – I

Introduction to semiconductor devices and Semiconductor components – Basic of Active Components BJT, FET, etc. Basic of passive components – Register, Inductor, Capacitor, LED etc.

Module – II

(Practical and Design)
i)   Design of simple DC power supply.
ii) Design of audio amplifier circuit.
iii) Design of LED running display.
iv) Design of Automated Light nighting system.
v)   Design of Borglar Alarm Circuit.
vi) Design of a Rain alarm system.
vii) Design of a Fire alarm system.
viii)Design of a FM transmitter.

Module – III

One Semiconductor based project need to submit.

Minor Courses

1. DataScience
2. Internet of Things (IoT)

Detailed Syllabus (Data Science)

S. No.	Course Code	Semesters	Course Structure Title	L	T	P	Credits
1	DAS-01	3rd sem	Introduction to Data Science	3	0	2	4
2	DAS-02	4th sem	Introduction to AI and ML	3	0	0	3
3	DAS-03	5th sem	Computational Data analytics	3	0	2	4
4	DAS-04	6th sem	Web Data Mining	3	0	0	3
5	DAS-05	7th sem	Analysing, Visualizing and Applying Data science with python	3	0	2	4
			TOTAL	**15**	**0**	**6**	**18**

Course Code	:	DAS-01
Course Title	:	Introduction to Data Science
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	DAS

Course Objective:

- To Provide the knowledge and expertise to become a proficient data scientist;
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
- Produce Python code to statistically analyse a dataset;
- Critically evaluate data visualisations based on their design and use for communicating stories from data;

Course Contents:

Module 1: [7 Lectures]
Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science.

Module 2: [7 Lectures]
Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDA- Quantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions.

Module 3: [11 Lectures]
Feature Generation and Feature Selection (Extracting Meaning from Data)- Motivating application: user (customer) retention- Feature Generation (brainstorming, role of domain expertise, and place for imagination)- Feature Selection algorithms.

Module 4: [10 Lectures]
Data Visualization- Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects- Exercise: create your own visualization of a complex dataset.

Module 5: [7 Lectures]
Applications of Data Science, Data Science and Ethical Issues- Discussions on privacy, security,

ethics- A look back at Data Science- Next-generation data scientists.

Lab Work:
1. Python Environment setup and Essentials.
2. Mathematical computing with Python (NumPy).
3. Scientific Computing with Python (SciPy).
4. Data Manipulation with Pandas.
5. Prediction using Scikit-Learn
6. Data Visualization in python using matplotlib

Text Books/References:
1. Data Sciences & Analytics, V.K. Jain, Khanna Publishing House.
2. Business Analytics: The Science of Data - Driven Decision Making, U Dinesh Kumar, John Wiley & Sons.
3. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Davy Cielen, John Wiley & Sons.
4. Joel Grus, Data Science from Scratch, Shroff Publisher/O'Reilly Publisher Media
5. Annalyn Ng, Kenneth Soo, Numsense! Data Science for the Layman, Shroff Publisher Publisher
6. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly Publisher.
7. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.
8. Jake VanderPlas, Python Data Science Handbook, Shroff Publisher/O'Reilly Publisher Media.
9. Philipp Janert, Data Analysis with Open Source Tools, Shroff Publisher/O'Reilly Publisher Media.

Course Outcomes: After completion of course, students would be able:
1. To explain how data is collected, managed and stored for data science;
2. To understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
3. To implement data collection and management scripts using MongoDB.

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Course Code	:	DAS-02
Course Title	:	Introduction to AI and ML
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	DAS

Course Objective:
- To understand basics of machine learning in data science.
- To understand various basic machine learning algorithm that can be used with various type of data.

Course Contents:

Module 1: [6 Lectures]

Linear Regression: Basic facts of linear regression, implementation of linear regression, case studies of linear regression using data set

Module 2: [8 Lectures]

Logistic Regression: Basic facts and implementation of logistic regression, solve a case study to predict output using existing data set

Module 3: [11 Lectures]

Clustering and Principle Component Analysis: K means and hierarchical clustering, how to make market strategies using clustering, recommendation and PCA

Module 4: [9 Lectures]

Support Vector Machine: basics of SVM and use it to detect the spam emails and recognize alphabets

Module 5: [8 Lectures]

Model Selection and advanced regression: use of Lasso and Ridge

Lab Work:

1. Use python to predict employee attrition in a firm and help them plan their manpower. (take data set from kaggle).
2. Create customer clusters using different market strategies on a data set.
3. Make a movie recommendation system.
4. Develop a prediction mechanism to predict which employee can go on leave in a company in near future.
5. Recognizing alphabets using SVM.

Text Books/References:

1. Machine Learning using Python , U Dinesh Kumar and Manaranjan Pradhan, John Wiley & Sons.
2. A Classical Approach to Artificial Intelligence, M.C. Trivedi, Khanna Publishing House.
3. Machine Learning, V.K. Jain, Khanna Publishing House.
4. Advanced Data Analytics Using Python: With Machine Learning, Deep Learning by By Sayan Mukhopadhyay, Apress.
5. Practical Data Mining" by Monte F. Hancock, Auerbach Publication.
6. "Machine Learning for Absolute Beginners: A Plain English Introduction (Second Edition)" by Oliver Theobald.
7. Practical Data Science with R, Nina Zumel, John Wiley & Sons.
8. Python for Data Science for Dummies, John Paul Mueller, Luca Massaron, John Wiley & Sons.
9. Big Data and Analytics, Seema Acharya and Subhashini Chellappan, Wiley Publication.
10. Introduction to Machine Learning, Jeeva Jose, Khanna Publishing House.

Course Outcomes: After completion of course, students would be able:

1. To explain how data is collected, managed and stored for data science;
2. To use various type of Machine learning model
3. To implement various ML algorithms on data models

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Course Code	:	DAS-03
Course Title	:	Computational Data Analytics
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	DAS

Course Objective:

- To learn how to think about your study system and research question of interest in a systematic way in order to design an efficient sampling and experimental research program.
- To understand how to analyze collected data to derive the most information possible about your research questions.

Course Contents:

Module 1: [6 Lectures]
Introduction to R Computing language. Best practices in executing Reproducible Research in data science, Sampling and Simulation. Descriptive statistics, and the creation of good observational sampling designs.

Module 2: [8 Lectures]
Data visualization, Data import and visualization, Introduction to various plots

Module 3: [10 Lectures]
Frequentist Hypothesis Testing, Z-Tests, Power Analysis

Module 4: [10 Lectures]
Linear regression, diagnostics, visualization, Likelihoodist Inference, Fitting a line with Likelihood, Model Selection with one predictor

Module 5: [8 Lectures]
Bayesian Inference, Fitting a line with Bayesian techniques, Multiple Regression and Interaction Effects, Information Theoretic Approaches

Lab Work:
1. To give a basic insight of R and its various libraries.
2. Libraries in R. R as a Data Importing Tool, Dplyr. Forcats.
3. Simulation and Frequentist Hypothesis testing, Simulation and Power.
4. Bayesian computation in R, Fitting a line with Bayesian techniques.

Text Books/References:

1. Beginner's Guide for Data Analysis using R Programming, Khanna Publishing House
2. Practical Data Science with R, Nina Zumel, John Wiley & Sons.

3. Big Data & Hadoop, V.K. Jain, Khanna Publishing House.
4. N. C. Das, Experimental Designs in Data Science with Least Resources, Shroff Publisher Publisher.
5. Hadley Wickham, Garret Grolemund, *R for Data Science*, Shroff Publisher/O'Reilly Publisher Publisher
6. Benjamin M. Bolker. *Ecological Models and Data in R*. Princeton University Press, 2008. ISBN 978-0-691-12522-0.
7. John Fox and Sanford Weisberg. *An R Companion to Applied Regression*. Sage Publications, Thousand Oaks, CA, USA, second edition, 2011. ISBN 978-1-4129-7514- 8.

Course Outcomes: After completion of course, students would be able to:
1. Explain how data is collected, managed and stored for data science;
2. When to use which type of Machine learning model.
3. Implement various ML algorithms on data models.

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Course Code	:	DAS-04
Course Title	:	Web Data Mining
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	DAS

Course Objective:

- To learn how to extract data from the Web.
- To understand how to analyze collected data to derive the most information

Course Contents:

Module 1: [6 Lectures]

Introduction to internet and WWW, Data Mining Foundations, Association Rules and Sequential Patterns, Basic Concepts of Association Rules, Apriori Algorithm, Frequent Itemset Generation, Association Rule Generation, Data Formats for Association Rule Mining, Mining with multiple minimum supports, Extended Model, Mining Algorithm, Rule Generation

Module 2: [8 Lectures]

Mining Class Association Rules, Basic Concepts of Sequential Patterns, Mining Sequential Patterns on GSP, Mining Sequential Patterns on Prefix Span, Generating Rules from Sequential Patterns

Module 3: [10 Lectures]

Concepts of Information Retrieval, IR Methods, Boolean Model, Vector Space Model and Statistical Language Model, Relevance Feedback, Evaluation Measures, Text and Web Page Pre-processing, Stopword Removal, Stemming, Web Page Preprocessing, Duplicate Detection, Inverted Index and Its Compression, Inverted Index, Search using Inverted Index, Index Construction, Index Compression, Latent Semantic Indexing, Singular Value

Decomposition, Query and Retrieval, Web Search, Meta Search, Web Spamming.

Module 4: [10 Lectures]

Link Analysis, Social Network Analysis, Co-Citation and Bibliographic Coupling, Page Rank Algorithm, HITS Algorithm, CommModuley Discovery, Problem Definition, Bipartite Core CommModuleies, Maximum Flow CommModuleies, Email CommModuleies, Web Crawling, A Basic Crawler Algorithm – Breadth First Crawlers, Preferential Crawlers, Implementation Issues – Fetching, Parsing, Stopword Removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and Conflicts.

Module 5: [8 Lectures]

Opinion Mining, Sentiment Classification, Classification based on Sentiment Phrases, Classification Using Text Classification Methods, Feature based Opinion Mining and Summarization, Problem Definition, Object feature extraction, Comparative Sentence and Relation Mining, Opinion Search and Opinion Spam. Web Usage Mining, Data Collection and Preprocessing, Sources and Types of Data, Key Elements of Web Usage Data Preprocessing, Data Modeling for Web Usage Mining, Discovery and Analysis of Web

Usage Patterns, Session and Visitor Analysis, Cluster Analysis and Visitor Segmentation, Association and Correlation Analysis, Analysis of Sequential and Navigation Patterns.

Text Books/References:

1. Mining the Web: Discovering Knowledge from Hypertext Data, Soumen Chakrabarti, Morgan Kaufmann Publishers.
2. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer Publications, 2011.
3. Jiawei Han, Micheline Kamber, Data Mining: Concepts and Techniques, Second Edition, Elsevier Publications 2010.
4. Anthony Scime, Web Mining: Applications and Techniques, 2005.
5. Kowalski, Gerald, Mark T Maybury: Information Retrieval Systems: Theory and Implementation, Kluwer Academic Press, 1997.
6. Mathew Russell, Mining the Social Web 2nd Edition, Shroff Publisher/O'Reilly Publisher Publication.
7. Data Mining and Data Warehousing Principles and Practical Techniques, Parteek Bhatia, Cambridge University Press.
8. Data Mining & Business Intelligence, Balram Krishan, Khanna Publishing House

Course Outcomes: After completion of course, students would be able:

1. To explain how data is can be collected from the Web.
2. To extract data and information from the webpages.
3. To make decision based on the data collected.

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Course Code	:	DAS-05
Course Title	:	Analysing, Visualizing and Applying data science with python
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	DAS

Course Objective:

- To learn how to use python for data science.
- To understand and use all the tools and libraries of python for data science.

Course Contents:

Module 1: [6 Lectures]

Data Analysis libraries: will learn to use Pandas DataFrames, Numpy multi-dimentional arrays, and SciPy libraries to work with a various dataset.

Module 2: [8 Lectures]

Pandas, an open-source library, and we will use it to load, manipulate, analyze, and visualize various datasets.

Module 3: [10 Lectures]

Scikit-learn, and we will use some of its machine learning algorithms to build smart models and make predictions, various parameters that can be used to compare various parameters.

Module 4: [10 Lectures]

Descriptive Statistics, Basic of Grouping, ANOVA, Correlation, Polynomial Regression and Pipelines, R-squared and MSE for In-Sample Evaluation, Prediction and Decision Making

Module 5: [10 Lectures]

Grid Search, Model Refinement, Binning, Indicator variables

Lab Work:

1. Demonstrate knowledge of Data Science and Machine Learning.
2. Apply Data Science process to a real life scenario.
3. Explore New York City - 311 Complaints and Housing datasets.
4. Analyze and Visualize data using Python.
5. Perform feature engineering exercise using Python.
6. Build and validate predictive machine learning model using Python.
7. Create and share Actionable Insights to real life data problems.

Text Books/References:

1. Taming Python by Programming, Jeeva Jose, Khanna Publishing House.
2. Data Visualization with Python and JavaScript, Kyran Dale, Shroff Publisher/O'Reilly Publisher Publication.
3. Data Science Using Python and R by Chantal D. Larose and Daniel T. Larose, Wiley Publication.
4. Data Science & Analytics (with Python, R, SPSS Programming), V.K. Jain, Khanna Publishing House.
5. Python for Data Science and Visualization -Beginners to Pro, Udemy.

Course Outcomes: After completion of course, students would:

1. To explain how data is can be collected from the Web.
2. To extract data and information from the webpages.
3. To make decision based on the data collected.

Detailed Syllabus (Internet of Things (IoT)

			Course Structure				
S. No.	Course Code	Semester	Title	L	T	P	Credits
1	IoT-01	3rd sem	Introduction to Internet of Things	3	0	2	4
2	IoT-02	4th sem	Introduction to Security of Cyber-PhysicalSystems	3	0	0	3
3	IoT-03	5th sem	Ubiquitous Sensing, Computing and Communication	3	0	2	4
4	IoT-04	6th sem	Embedded Systems for IoT	3	0	0	3
5	IoT-05	7th sem	IoT with Arduino, ESP, and Raspberry Pi	3	0	2	4
			TOTAL	15	0	6	18

Detailed Syllabus

Course Code	:	IoT-01
Course Title	:	Introduction to Internet of Things
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	IoT

Course Objective:

- To make students know the IoT ecosystem.
- To provide an understanding of the technologies and the standards relating to the Internet of Things.
- To develop skills on IoT technical planning.

Course Contents:

Module 1 [8 Lectures]
IoT & Web Technology: The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Module 2 [9 Lectures]
M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, the international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module 3 [9 Lectures]
IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference

Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module 4 [8 Lectures]

IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Module 5 [8 Lectures]

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smart Approach. Data Aggregation for the IoT in Smart Cities, Security.

Text Books/References:

1. Dr. Jeeva Jose, Internet of Things, Khanna Publishing House.
2. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher/O'Reilly Publisher.
3. Internet of Things, RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, John Wiley and Sons.
4. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
5. Cuno Pfister, "Getting Started with the Internet of Things", Shroff Publisher/Maker Media.
6. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications.
7. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/Maker Media Publishers.

Corresponding Online Resources:

1. https://www.coursera.org/specializations/internet-of-things

Course Outcomes: After completion of course, students would be able:

1. To understand the technology and standards relating to IoTs.
2. To understand the critical ecosystem required to mainstream IoTs.
3. To Acquire skills on developing their own national and enterprise level technical strategies.

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Course Code	:	IoT-02
Course Title	:	Introduction to Security of Cyber-Physical Systems
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	IoT

Course Objective:

- To learn the basics of security and various types of security issues.
- To study different cryptography techniques available and various security attacks.
- Explore network security and how they are implemented in real world.
- To get an insight of various issues of Web security and biometric authentication.

Course Contents:

Module 1 [6 Lectures]
Overview of Security and Privacy in Information System.

Module 2 [10 Lectures]

Applied Cryptography & Intrusion Detection, Architecture of Applied Cryptography, One Way Hash Function and Integrity, Encryption Algorithms and Confidentiality, Digital Signature and Authentication (DH, RSA, 2 class), Intrusion Detection and Information Theory.

Module 3 [10 Lectures]

Internet of Things Security, Security and Privacy for IoT Case Study: Smart Home, Smart Grid Network, Modern Vehicle, Wearable Computing & BYOD, Mobile HealthCare.

Module 4 [8 Lectures]

Software-Defined Networks, Introduction of Software-Defined Networks, Security for Software-Defined Networks, Privacy Leakages for Software-Defined Networks, Case Studies: How to Attack Software-Defined Networks.

Module 5 [8 Lectures]

Cyber-Physical Systems (CPS), CPS - Platform components, CPS implementation issues, Intelligent CPS, Secure Deployment of CPS.

Text Books/References:

1. Cyber Security, Nina Godbole, John Wiley & Sons.
2. Li Da Xu, Shancang Li, "Securing the Internet of Things", Syngress.
3. Alasdair Gilchrist, "IoT Security Issues", De Gruyter
4. Sean Smith, "The Internet of Risky Things", Sean Smith, Shroff Publisher/O'Reilly Publisher
5. Dr. Jeeva Jose, Internet of Things, Khanna Publishing House.

Course Outcomes: After completion of course, students would be able:
1. To Apply basics of security and issues related to it.
2. To use biometric techniques available and how they are used in today's world.
3. To investigate Security issues in web and how to tackle them.
4. To Learn mechanisms for transport and network security

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Course Code	:	IoT-03
Course Title	:	Ubiquitous Sensing, Computing and Communication
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	IoT

Course Objective:

- Basic introduction of all the elements of IoT-Mechanical, Electronics/sensor platform, Wireless and wireline protocols, Mobile to Electronics integration, Mobile to enterprise integration.
- To have an understanding of basics of open source/commercial electronics platform for IoT.
- To have an understanding of basics of open source /commercial enterprise cloud platform for IoT.

Course Contents:

Module 1

Introduction, Overview, Challenges in IoT, Networking Basics of IoT, NFC, Wireless LAN.

Module 2

Location in ubiquitous computing: Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications, Location based social networks (LBSN), LBSN Recommendation.
Context-aware computing: Context and Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture.

Module 3

Privacy and security in ubiquitous computing, Energy constraints in ubiquitous computing.
Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper, Mobile social networking & crowd sensing, Event based social network.

Module 4

Mobile affective computing: Human Activity and Emotion Sensing, Health Apps, Mobile p2p computing, Smart Homes and Intelligent Buildings, Mobile HCI, Cloud centric IoT, Open challenges, Architecture, Energy Efficiency, Participatory sensing, Protocols, QoS, QoE.

Module 5

IoT and data analytics IoT and Data Management, Data cleaning and processing, Data storage models.
Search techniques, Deep Web, Semantic sensor web, Semantic Web Data Management, Searching in IoT.
Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High-dimensional Data Processing, Parallel and Distributed Data Processing.

Text Books/References:

1. N. Jeyanthi, Ajith Abraham, Hamid Mcheick, "Ubiquitous Computing and Computing Security of IoT".
2. John Krumm, Ubiquitous Computing Fundamentals, CRC Press.
3. Dirk Slama, "Enterprise IoT", Shroff Publisher/O'Reilly Publisher
4. Dr. Jeeva Jose, Internet of Things, Khanna Publishing House.

Course Outcomes: After completion of course, students would be able:
1. To understand merging technological options, platforms and case studies of IoT implementation in home & city automation.
2. To determine the Market perspective of IoT.

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Course Code	:	IoT-04
Course Title	:	Embedded Systems for IoT
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	IoT

Course Objective:

- To make students know the basic concept and architecture of embedded systems.
- Different design platforms used for an embedded system for IoT applications.
- To have knowledge about the IoT enabled technology.

Course Contents:

Module 1 [7 Lectures]
Purpose and requirement specification, IoT level specification, Functional view specification, Operational view specification, Device and component integration, Pillars of Embedded IoT and Physical Devices: The internet of devices.

Module 2 [8 Lectures]
Design of Embedded Systems: Common Sensors, Actuators, Embedded Processors, Memory Architectures, Software architecture.

Module 3 [7 Lectures]
Inputs and Outputs: Digital Inputs and Outputs, Digital Inputs, Digital Outputs, BusIn, BusOut, and BusInOut, Analog Inputs and Outputs, Analog Inputs, Analog Outputs, Pulse Width Modulation (PWM), Accelerometer and Magnetometer, SD Card, Local File System (LPC1768).

Module 4 [10 Lectures]
IoT Enabling Technologies: Communications, RFID and NFC (Near-Field Communication), Bluetooth Low Energy (BLE), LiFi, 6LowPAN, ZigBee, Z-Wave, LoRa, Protocols, HTTP, WebSocket, MQTT, CoAP, XMPP, Node-RED, Platforms, IBM Watson IoT—Bluemix, Eclipse IoT, AWS IoT, Microsoft Azure IoT Suite, Google Cloud IoT, ThingWorx, GE

Predix, Xively, macchina.io, Carriots.

Module 5 [10 Lectures]

Web of Things and Cloud of Things: Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Cloud of Things. IoT Physical Servers,

Cloud Offerings and IoT Case Studies: Introduction to Cloud Storage Models, Communication API.

Text Books/References:

1. Dr. Jeeva Jose, Internet of Things, Khanna Publishing House.
2. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, Internet of Things, John Wiley and Sons.
3. Klaus Elk, "Embedded Software for the IoT".
4. Perry Xiao, "Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed".
5. Elizabeth Gootman et. al, "Designing Connected Products", Shroff Publisher/O'Reilly Publisher.

Corresponding Online Resources:

1. Introduction to the Internet of Things and Embedded Systems, https://www.coursera.org/learn/iot

Course Outcomes: After completion of course, students would be able to:
1. Understand the embedded system concepts and architecture of embedded systems.
2. Understand the different hardware/software co-design techniques for microcontroller-based embedded systems, apply techniques in IoT applications.
3. To be able to design web/cloud based IoT applications.

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Course Code	:	IoT-05
Course Title	:	IoT with Arduino, ESP, and Raspberry Pi
Number of Credits	:	4 (L: 3; T: 0; P: 2)
Course Category	:	IoT

Course Objective:

- To give students hands-on experience using different IoT architectures.
- To provide skills for interfacing sensors and actuators with different IoT architectures.
- To develop skills on data collection and logging in the cloud.

Course Contents:

Module 1 [5 Lectures]

IoT- introduction and its components, IoT building blocks, Sensors and Actuators, IoT Devices, IoT boards (Arduino Uno, ESP 8266-12E Node MCU, and Raspberry Pi 3).

Module 2 [10 Lectures]

Arduino Uno – getting started with the Uno boards, blink program, connection of sensors to the Uno board, reading values of sensors from the Uno board, interrupts. Case study: Temperature/Humidity Control; Case Study: Sending values Temperature/Humidity values to the Internet via GSM module.

Module 3 [10 Lectures]

ESP 8266-12E Node MCU – getting started with the ESP board, Micropython and Esplorer IDE, Flushing the ESP8266 board with micropython, connecting sensors to the ESP board, Connecting ESP board to WiFi, Interfacing ESP with the Cloud (REST API- GET, POST, MQTT), interrupts, comparison of ESP 32 board with the ESP 8266 board. Case Study: Switching light on /off remotely. Case Study: Voice-based Home

Automation for switching lights on/off (Android phone – Google Assistant (Assistant <-> IFTTT), MQTT (ESP <-> IFTTT), ESP 8266 <-> Lights).

Module 4 [8 Lectures]

Raspberry Pi 3 - Rpi3 introduction and installing the Raspbian Stretch OS, Headless - Computer and Rpi3 configuration to connect through SSH via Ethernet, Headless - connecting Rpi3 remotely without Ethernet cable via SSH, IP address, Rpi 3 - Testing the GPIO pins through Scripts.

Module 5 [9 Lectures]

Raspberry pi3 interfacing with Sensor DHT11, Raspberry pi3 python library install and reading sensor feed, 'Plug and play ' type cloud platform overview for integration to IOT devices, 'Plug and play' cloud platform for integration to IOT device - actuator (LED), Plug and play platform - Custom widget (DHT11-Sensor) integration through Python. New - Raspeberry Pi 4 Vs Raspberry Pi3 Mobel B Comparison, LoRawan /LPWAN – Overview.

Text Books/References:

1. Dr. Jeeva Jose, Internet of Things, Khanna Publishing House.
2. Rao, M. (2018). Internet of Things with Raspberry Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects. Packt Publishing Ltd
3. Baichtal, J. (2013). *Arduino for beginners: essential skills every maker needs*. Pearson Education.
4. Schwartz, M. (2016). *Internet of Things with ESP8266*. Packt Publishing Ltd.
5. Richardson, M., & Wallace, S. (2012). *Getting started with raspberry PI*. " O'Reilly Publisher Media, Inc."

Software/Hardware Requirements:

Python, IOT boards - Arduino UNO, NODEMCU ESP 8266, Raspberry PI 3, Few resistors, potentiometer (5K~10K OHM), breadboard, LEDs, DHT 11 sensor.

Course Outcomes: After completion of course, students would:

1. To understand Arduino Uno, NODE MCU 8266 and Raspberry PI along with critical protocols and its communication to cloud.
2. To apply commonly used IOT protocols such as REST API, MQTT through IOT based demonstration.
3. To solve analog sensor and digital sensor Interfacing with IOT devices.

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