Course Structure and Syllabus

For

Bachelor of Technology (B.Tech.)
(Electronics Engineering)

as

Recommended by BOS
(from academic session 2023-24)

महात्मा ज्योतिबा फुले
रुहेलखण्ड विश्वविद्यालय, बरेली

Department of Electronics & Instrumentation Engineering
Faculty of Engineering and Technology (FET)
MJP Rohilkhand University, Bareilly (UP) 243006

September 2023

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

FACULTY OF ENGINEERING AND TECHNOLOGY
M.J.P. ROHILKHAND UNIVERSITY, BAREILLY

Minutes of the BoS Meeting

Bachelor of Technology (B.Tech.)
(Electronics Engineering)

A meeting of the BoS committee, in the Department of Electronics and Instrumentation Engineering, FET, M.J.P Rohilkhand University Bareilly was held on Monday 25th September 2023 to discuss and finalized the syllabus, scheme of course and panel of experts for B.Tech. (Electronics Engineering) course of the department effective from academic session 2023-24.

Following members were present in this meeting:

(A) External Experts:

1. Prof. HK Tyagi, Department of Electronics, Kurukshetra University, Kurukshetra
2. Prof. Abhishek Tomar, Department of EC Engg, GBPUAT, Pantnagar

(B) Internal Members

1. Prof. Sanjeev, Head of the Department.
2. Prof. Yograj Singh Duksh
3. Prof. Anil Kumar Singh
4. Prof. Rakesh Kumar Maurya
5. Prof. Yatendra Kumar
6. Dr. (Mrs.) Reena Pant, Associate Professor
7. Dr. Ashish K. Jain, Associate Professor
8. Dr. Deepak Gangwar, Associate Professor
9. Dr. Mukul K. Gupta, Associate Professor

HEAD
Deptt. of E&I Engg.
M.J.P. ROHILKHAND UNIVERSITY
Bareilly-243006 (U.P.) India

Recommendations of the BoS Committee:

1. ***The name of B.Tech. (Electronics and Instrumentation) degree is changed to B.Tech.(Electronics Engineering) as per the AICTE extension of approval letter no. F.No. Northern/1-36523406545/2023/EOA dated 2nd June 2023 (A copy is attached). It is also approved by the BOS committee and it will be effective from the academic session 2023-24 (for the students admitted in the first semester in current AY).***
2. The minor degree in 5 emerging areas will also continue with this new B.Tech. (Electronics Engineering) course.
3. The syllabus and course structure has been updated as per latest AICTE guidelines and prefix to the code of the subject also changed to 'EL' (in place of EI)
4. The panel of experts' for question paper setting for theory subjects and Lab. examination are also recommended by the committee and is attached herewith.

SCHEME OF COURSES FOR B. TECH.

B. Tech. Electronics Engineering

Ist Year I Semester

S. No	Subject Code	Subject	Teaching Schedule			Credits
			L	T	P	
1.	PH-101T	Engineering Physics-I (All Branches)	3	1	0	4
2.	CY-101T	Engineering Chemistry (EE, EL & EC)	3	1	0	4
3.	MA-101T	Engineering Mathematics-I (All Branches)	3	1	0	4
4.	HU-101T	Communicative English (EE, EL & EC)	2	1	0	3
5.	CS-101T	Computer Fundamentals & Programming (EE, EL & EC)	3	1	0	4
6.	ME-107T	Engineering Graphics (CSIT, CH & ME)	1	2	0	2
7.	EE-101T	Basic Electrical Engineering (EE, EL, & EC)	3	1	0	4
8.	EL-101T	Basic Electronics Engineering (ME, CSIT,& CH)	3	1	0	4
9.	CY-103T	Environmental Studies (CSIT, CH & ME)	3	0	0	2
10.	HU-103T	Fundamentals of Economics (ME, CSIT & CH)	3	0	0	2
11.	ME-101T	Manufacturing Techniques (CS, CH, ME)	2	0	0	2
12.	ME-105T	Basic Mechanical Engineering (EC, EL, EE)	3	1	0	4
		Total				**22/25**
Laboratory Courses						
13.	PH-101P	Engineering Physics Lab (CSIT, CH & ME)	0	0	3	2
14.	CY-101P	Engineering Chemistry Lab (EE, EL & EC)	0	0	3	2
15.	CS-101P	Computer Programming Lab (EE, EL & EC)	0	0	3	2
16.	EE-101P	Basic Electrical Engg. Lab (EE, EL & EC)	0	0	3	2
17.	EL-101P	Basic Electronics Engg. Lab (ME, CSIT & CH)	0	0	3	2
18.	ME-101P	Workshop Practice Lab (ME, CSIT & CH)	0	0	3	2
		Total				**6/6**
		G. Total				**28/31**

B.Tech. Electronics Engineering

Ist Year II Semester

S. No	Subject Code	Subjects	Teaching Schedule			Credits
			L	T	P	
1.	PH-102T	Engineering Physics-II (All Branches)	3	1	0	4
2.	CY-101T	Engineering Chemistry (ME, CSIT & CH)	3	1	0	4
3.	MA-102T	Engineering Mathematics-II (All Branches)	3	1	0	4
4.	HU-101T	Communicative English (CSIT, CH, ME)	2	1	0	3
5.	CS-101T	Computer Fundamentals & Programming (CSIT, CH, ME)	3	1	0	4
6.	ME-107T	Engineering Graphics (EE, EL & EC)	1	2	0	2
7.	EE-101T	Basic Electrical Engineering (ME, CSIT & CH)	3	1	0	4
8.	EL-102T	Basic Electronics Engineering (EE, EL & EC)	3	1	0	4
9.	CY-103T	Environmental Studies (EE, EL & EC)	3	0	0	2
10.	HU-103T	Fundamentals of Economics (EE, EL & EC)	3	0	0	2
11.	ME-101T	Manufacturing Techniques (EC, EL, EE)	2	0	0	2
12.	ME-105T	Basic Mechanical Engineering (CSIT, CH, ME)	3	1	0	4
		Total				**25/22**
Laboratory Courses						
11.	PH-101P	Engineering Physics Lab (EE, EL & EC)	0	0	3	2
12.	CY-101P	Engineering Chemistry Lab (ME, CSIT & CH)	0	0	3	2
13.	CS-101P	Computer Programming Lab (ME, CSIT & CH)	0	0	3	2
14.	EE-101P	Basic Electrical Engg. Lab (ME, CSIT & CH)	0	0	3	2
15.	EL-102P	Basic Electronics Engg. Lab (EE, EL & EC)	0	0	3	2
16.	ME-101P	Workshop Practice Lab (EE, EL & EC)	0	0	3	2
		Total				**6/6**
		G.Total				**31/28**

B. Tech (Electronics Engineering)

2nd Year III Semester

S. No	Subjects Code	Subjects	Teaching Schedule			Credits
			L	T	P	
1.	EL-201T	Analog Electronics (EL, EE, EC)	3	1	0	4
2.	EL-203T	Electronic Measurement & Instrumentation (EC, EL)	3	1	0	4
3.	CS-203T	Data Structure	3	1	0	4
4.	EC-203T	Electromagnetic Theory (EC, EL)	3	1	0	4
5.	EE-201T	Network Analysis & Synthesis	3	1	0	4
6.	MA-201T	Engineering Mathematics-III	3	1	0	4
8.	EL-201P	Analog Electronics Lab (EL)	0	0	3	2
9.	EL-203P	Electronic Measurement & Instrumentation Lab (EL)	0	0	3	2
10.	CS-201P	Computer Programming Lab-II	0	0	3	2
			Total Credits			**30**

B.Tech. Electronics Engineering

2nd Year IV Semester

S. No	Subjects Code	Subjects	Teaching Schedule			Credits
			L	T	P	
1.	EL-202T	Linear Integrated Circuits (EC, EL, EE)	3	1	0	4
2.	EC-202T	Signals & Systems (EC, EL)	3	1	0	4
3.	EL-204T	Digital Electronic Circuits (EL)	3	1	0	4
4.	CS-204T	Computer Organization	3	1	0	4
5.	EL-206T	Solid State Materials And Devices	3	1	0	4
6.	HU-204T	Human Value and Professional Ethics	2	0	0	2
7.	EL-204P	Digital Electronic Circuits Lab (EL)	0	0	3	2
8.	EL-206P	Linear Integrated Circuit Lab (EC, EL, EE)	0	0	3	2
9.	EL-208P	Python Programming Lab	0	0	3	2
			Total Credits			**28**

B.Tech. Electronics Engineering

3rd Year V Semester

S. No	Subjects Code	Subjects	Teaching Schedule			Credits
			L	T	P	
1.	EC-301T	Analog Communication Systems (EC, EL)	3	1	0	4
2.	EL-301T	Microprocessors & Their Applications (EC, EL, EE, CSIT)	3	1	0	4
3.	EL-303T	Sensors and Transducers (EL)	3	1	0	4
4.	EL-305T	Antenna Engineering	3	1	0	4
5.	EE-301T	Control Systems (EC,EL,EE)	3	1	0	4
6.		Pool Elective 1	3	1	0	4
7.	EC-301P	Analog Communication Lab (EC, EL)	0	0	3	2
8.	EL-301P	Microprocessor Lab (EC, EL, EE, CSIT)	0	0	3	2
9.	EL-303P	Sensors and Transducers Lab (EL, CH)	0	0	3	2
10.	EL-307P (CH)	Instrumentation and Analysis Lab. (For CH branch only)	0	0	3	2
Total Credits						**32**

B.Tech. Electronics Engineering

3rd Year VI Semester

S. No	Subjects Code		Teaching Schedule			Credits
			L	T	P	
1.	EC-302T	Digital Signal Processing (EC, EL)	3	1	0	4
2.	EL-302T	Embedded Systems (EC, EL)	3	1	0	4
3.	EC-304T	Digital Communication System (EC, EL)	3	1	0	4
4.	EL-304T	VLSI Design	3	1	0	4
5.	EL-306T	RF and Microwave engineering	3	1	0	4
6.		Pool Elective 2	3	1	0	4
7.	EL-308T	Technical Writing	1	0	0	1
8.	EL-302P	Embedded Systems Lab (EC, EL)	0	0	3	2
9.	EC-304P	Digital Communication Lab (EC, EL)	0	0	3	2
10.	EL-304P	Product Design Lab. (EL)	0	0	3	2
Total Credits						**31**

B.Tech. Electronics Engineering

4th Year VII Semester

S. No	Subject Code	Subjects	Teaching Schedule			Credits
			L	T	P	
1	EL-401T	Biomedical Engineering	3	1	0	4
2.	EL-403T	Metrology and Calibration	3	1	0	4
3.		Open Elective	3	1	0	4
4.		Pool Elective 3	3	1	0	4
5.		Pool Elective 4	3	1	0	4
6		Pool Elective 5	3	1	0	4
7.	EL-407	Industrial Training (EI)	0	0	3	2
8	EL-409	Seminar (EI)	0	0	3	2
9	EL-401P	Biomedical Engineering Lab	0	0	3	2
10	EL-405P	Simulation Engineering Lab	0	0	3	2
Total Credits						**28**

B.Tech. Electronics Engineering

4th Year VIII Semester

S. No	Subjects Code	Subjects	Teaching Schedule			Credits
			L	T	P	
1.	EL-402P	Major Project/Internship				24
Total Credits						**24**

Note:
Under the major project, student will do the project work/Internship in our university or any other identified industry/research institute/University/ of repute. The students will devote his/her 8th semester for this project/internship and prepare a comprehensive project report whose evaluation will be done by the department.

In the middle of the project work/internship, student has to deliver a progress report presentation in the department. On the basis of progress report presentation and a confidential report from the concerned guide, the sessional marks will be prepared by the departmental project coordinator duly nominated by the Head of the department.

The evaluation of project/internship report will be done by the external experts approved by the Vice-Chancellor at the end of the semester.

List of Pool Elective:

5th Semester

Pool Elective 1

EL- 307T	Semiconductor Fabrication technology
EL-309T	PCB Design & Technology
EL- 311T	Mixed Signal Design

6th Semester

Pool Elective 2

EL-310T	Artificial Intelligence and Machine Learning
EL-312T	Information theory and coding
EL-314T	Computational Electromagnetics

7th Semester

Pool Elective 3

EL-407T	Nano Electronics
EL-409T	Microwave Integrated Circuit
EL-411T	Introduction to MEMS

Pool Elective 4

EL-413T	Optical fiber communication
EL-415T	Wireless communication
EL-417T	Wireless sensor network

Pool elective 5

EL-419T	Digital System Design
EL-421T	Digital Audio Processing
EL-423T	Milli meter wave Device and circuits

List of Open Elective:

1.	MA-491T	Operation Research
2.	CY-401T	Polymeric Materials and their Applications
3.	PH-419T	Futuristic Materials
4.	HU-449T	Principles of Management
5.	HU-409T	Quantitative Methods in Economics

Note: The Pool Elective and Open Elective Subjects offered by various Departments of FET may be added/modified/replace as future requirement.

Minor Degree Subjects

Minor Degree in "Artificial Intelligence and Machine Learning"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	AIML-01T	Introduction to AI & Machine Learning	3	0	0	3
2	AIML-01P	Introduction to AI & Machine Learning Lab	0	0	2	1
3	AIML-02T	Introduction to Data Analytics	3	1	0	4
4	AIML-03T	Deep Learning and Neural Network	3	1	0	4
5	AIML-04T	Special topics in Artificial Intelligence	3	1	0	4
6	AIML-05T	Applications of AI	3	0	0	3
7	AIML-05P	Applications of AI Lab	0	0	2	1
TOTAL			**15**	**3**	**4**	**20**

Minor Degree in "Internet of Things"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	IoT-01T	Introduction to Internet of Things	3	1	0	4
2	IoT-02T	Introduction to Security of Cyber-Physical Systems	3	1	0	4
3	IoT-03T	Ubiquitous Sensing, Computing and Communication	3	1	0	4
4	IoT-04T	Embedded Systems for IoT	3	0	0	3
5	IoT-04P	Embedded Systems for IoT Lab	0	0	2	1
6	IoT-05T	IoT with Arduino, ESP, and Raspberry Pi	3	0	0	3
7	IoT-05P	IoT with Arduino, ESP, and Raspberry Pi LAB	0	0	2	1
TOTAL			**15**	**3**	**4**	**20**

Minor Degree in "Robotics"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	ROB-01T	Introduction to Robotics	3	1	0	4
2	ROB-02T	Mechanics of Robots	3	1	0	4
3	ROB-03T	Microprocessor & Embedded Systems	3	0	0	3
4	ROB-03P	Microprocessor & Embedded Systems Lab	0	0	2	1
5	ROB-04T	Control of Robotic Systems	3	0	0	3
6	ROB-04P	Control of Robotic Systems Lab	0	0	2	1
7	ROB-05T	Project in Robotics	1	0	6	4
TOTAL			**13**	**2**	**10**	**20**

Minor Degree in "Electric Vehicles"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	EV-01T	Power Train and Motor Design	3	1	0	4
2	EV-02T	Battery Management System	3	1	0	4
3	EV-03T	EV Charging Infrastructure technology	3	0	0	3
4	EV-03P	EV Charging Infrastructure technology LAB	0	0	2	1
5	EV-04T	Embedded system for EV	3	0	0	3
6	EV-04P	Embedded system for EV Lab	0	0	2	1
7	EV-05T	Modelling of Electric Vehicles	1	0	6	4
TOTAL			**13**	**2**	**10**	**20**

Minor Degree in "Industrial Automation"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	IA-01T	Transducer and Applications	3	0	0	3
2	IA-01P	Transducer and Applications lab	0	0	2	1
3	IA-02T	Process Control Instrumentation	3	0	0	3
4	IA-02P	Process Control Instrumentation lab	0	0	2	1
5	IA-03T	PLC and DCS	3	1	0	4
6	IA-04T	Intelligent Instrumentation	3	1	0	4
7	IA-05T	Communication Protocols for Instrumentation	3	1	0	4
TOTAL			**15**	**3**	**4**	**20**

SEMESTER-1

PH-101T Engineering Physics-I (All Branches) Credits-4 LTP: 3 1 0

Interference: Coherent sources, Theory of interference, displacement of fringes, Fresnel‟s biprism experiment, Interference in thin film, wedge shaped film, Newton‟s rings.

Diffraction: Basic idea of Fresnel & fraunhofer diffraction, single, double and n slit diffraction, diffraction grating, Rayleigh‟s criterion of resolution, resolving power of telescope, microscope and grating.

Polarization: Phenomenon of double refraction, Malus law, Nicol prism, quarter wave and half wave plates, production and analysis of plane, circularly and elliptically polarized light, optical activity, specific rotation, Lorentz half shade and biquartz proarimeters.

Wave Mechanics: Elementary idea of quantization, black body radiation, Frank-Hertz experiment, Photoelectric effect. Wave particle duality, De Broglie concept of matter waves, Heisenberg‟s uncertainty principle, Schrodinger‟s wave equation, physical significance of wave function, applications of Schrodinger‟s wave equation: (i) Particle in one dimensional box. (ii) Potential Step (iii) Potential barrier-quantum mechanical tunneling (Basic idea).

Solid State Physics: Structure of crystalline solid: Lattice translational vectors, unit cell, Bravais lattice, Miller indices and simple crystal structures.

Free electron model: Free electron gas in one and three dimensions, Fermi energy, Density of states, Heat capacity of the electron gas, failure of free electron model.

Band theory: Kronig Penny model, motion of electrons in one dimension according to the band theory, effective mass of an electron, concept of hole, distinction between metals, insulators and intrinsic semi-conductors.

Books:

1) Geometrical & Physical Optics: B.K.Mathur
2) Introduction of Solid State Physics: C. Kittel
3) Solid State Physics: A.J. Dekkar
4) Quantum Mechanics: Singh and Bagdel
5) Optics: Ajai Ghatak
6) Quantum Mechanics: B.K. Agarwal & Hari Prakash
7) Optics: A.H. Flower
8) Geometrical & Physical: Zenkin‟s & White
9) Quantum Mechanics: Eisberg

Subject: Engineering Chemistry Code: CY-101T Credits: 4 LTP: 3 1 0

Schrődinger equation: origin of quantization; applications of particle in a box problem; hydrogen atom; properties of atomic orbitals; many electron atoms; molecular orbital theory; bonding and intermolecular forces.

Thermodynamics: Fundamental definition and concepts of thermodynamics; Work, heat and energy; First law: *Cp* and *Cv*; Second law: entropy; Helmholtz and Gibbs Energy; chemical potential; Third law; phase equilibria; chemical equilibrium.

Chemical kinetics: Rate laws; elementary reaction and chain reaction.

Periodic table and periodic properties: basis of periodic table, trends in size, electron affinity, ionization potential and electro negativity, Use of Ellingham diagram and thermodynamics in the extraction of elements; Transition metal chemistry: inorganic complexes, isomerism, nomenclature; bonding in transition metal complexes; valence bond and crystal field theory, magnetism, bonding aspects, structural distortion; Bioinorganic chemistry: storage and transport proteins; Catalysis: hydrogenation, hydroformylation and olefin metathesis.

Organic Chemistry: Hűckel treatment of ethylene, butadiene and benzene, concept of aromaticity, configuration, molecular chirality and isomerism, conformation of alkanes and cycloalkanes, reactivity of carbonyl groups (additions, addition-eliminations, reactions due to acidic proton, reactivity of acid halide, ester and amide), functional group inter-conversions involving oxidation and reduction. Introduction to bio-organic chemistry: carbohydrates, amino acids proteins and nucleic acids. Polymer chemistry definition, classification of polymers, orientation of polymers, types of polymerization, Mechanism of addition and condensation polymerization, thermo plastic and thermo setting revius: Important thermosetting and thermoplastic polymers: eg. Bakelite, polyester, cellulose derivatives, PVC, Poly ethylene, Teflon, Polystyrene, Nylon Natural and synthetic rubbers.

Suggested Books:

1. P.W. Atkins, **Physical Chemistry** (7th Edition), Oxford University Press, 2006.
2. I. A. Levine, **Physical Chemistry**, McGrawHill, 2009
3. D.A. McQuarrie and J.D. Simon, **Physical Chemistry -a Molecular Approach**, Viva Books Pvt. Ltd., 1998.
4. R.T. Morrison and R.N. Boyd, **Organic Chemistry**, Prentice Hall of India Pvt. Ltd., 5th Ed, 1990
5. G. Solomons and C. Fryhle, **Organic Chemistry**, John Wiley & Sons (Asia) Pte Ltd.
6. J.D. Lee, **Concise Inorganic Chemistry**, (5th Edition), ELBS, 1996.
7. D. F. Shriver and P. W. Atkins, **Inorganic Chemistry,** Oxford University Press, 2006
8. F.W.Bill mayer, Polymer Science, Tata McGraw Hill.

Subject: Engineering Mathematics-I	**Code: MA-101T,**	**Credits: 4**
Branches :All,	**Sem: I/II Semester**	**LTP: 3 1 0**

UNIT: 1 Differential Calculus:

Limit, continuity and differentiability of functions of single variable. Successive, Differentiations, Leibnitz Theorem, Expansion of functions by Maclaurin‟s and Taylor‟s theorems.

Functions of several variables: Partial derivatives, Euler‟s theorem, change of variables, total differential coefficients, maxima and minima, Lagrange‟s method of multiplier.

UNIT: 2 Integral Calculus:

`Fundamental and mean value theorems of integral calculus.

Reduction formulae, Walli‟s formula, Beta and Gamma functions, Double and Triple integrals, change of orders of integrations. Area enclosed by plane curves, surfaces and volumes of revolutions.

UNIT: 3 Vectors and Matrices:

Differentiations and integrations of vectors. Gradient, Divergence and Curl. Vector identities, Green‟s, Gauss‟s and stoke‟s theorems with applications.

Types and algebra of matrices, rank, solution of simultaneous linear equations, Eigen values and Eigen vectors, diagonalisation of matrices, Cayley-Hamilton Theorem.

References:

1. E. Kreyszig: Advance Engineering mathematics, John Wiley & Sons, 2005.
2. B.V. Ramana: Higher Engineering Mathematics, Tata McGraw Hill Co. Ltd., 2008
3. R.K. Jain & S.R.K. Iyenger: Advance Engineering Mathematics, Narosa Publishing House, 2002.
4. J.C. Sharma: Vector Algebra, Students & Friends Co. Ltd. Agra.
5. J.K.Goel & K.P.Gupta: Matrix algebra, Students & Friends Co. Ltd. Agra.
6. H.K.Dan: Advanced Engineering Mathematics.

Subject: Communicative English Code: HU-101T Credits: 3 LTP: 2 1 0

This course has a double purpose. It introduces literature and its forms and also helps students learn the English language. The linguistic aspect will be dealt with by concentrating on the dictionary skills and introducing principles of pronunciation, vocabulary development, and syntax. The main topics include:

(a) **Pronunciation:** Basic sounds of English (vowels and consonants) and word-stress

(b) **Vocabulary:** word-formation (prefixes and suffixes), synonyms and antonyms

(c) **Syntax:** parts of speech, active and passive voice, direct and indirect speech, tenses, basic sentence patterns, etc. The literary aspect will be dealt with through suitable texts such as poems, short stories and plays (chosen be the instructors). The main topics for discussion will be:

(a) What is literature?

(b) The nature of literary language (mainly "figurative "language)

(c) The literary forms or genres

(d) Literature and socio-cultural context

Pre-Requisities of Scientific Writing: Salient features: BOCUST formula. Grammatical pre-requisites: Usage, Sentence fragments, questions tag. Modifiers, connectives Split infinitives, Dangling participle Gereunds, ellipsis coherence & unity: Method.

CS-101T Computer Fundamental and Programming Credits 4(3-1-0)

Section A: Computer Fundamentals

1. **Introduction:** Basic definition, Classification of Computers, Block diagram of computer and brief idea of its part (I/O, Memory, control unit) with their working and example.
2. **Number System:** Introduction, Data representation-Decimal, Binary, octal, Hexadecimal and their inter convertibility.
3. **Planning the computer program:** Purpose of program planning, algorithms, flow charts, Pseudo code.
4. **Computer Software:** Introduction to software, hardware, Firmware with example, Type of software, Translators and their types (compiler, interpreter, assembler etc.).
5. **Basic operating system concepts:** OS, Types of OS (MS-DOS,WINDOWS) Role of OS with its characteristics in brief (Multi-programming, Multitasking, Multiprocessing, Multi-threading, Time-sharing, online-processing, Real-time processing).

Section B: Programming in C

6. **Introduction :**Introduction to C Programming Language, structure of C programs, compilation and execution of C programs, debugging techniques, data types and sizes, declaration of variables, modifiers, identifiers and keywords, symbolic constants, storage classes (automatic, external, register and static) and their use –when and where , macros, the Cpre-processor.
7. **Operators:** unary operators, Arithmetic and logical operators, bitwise operators, assignment operators ,relational operators, shift operators, comma operators, conditional operators , size of operators ,type conversion , type casting .
8. **Control statements:** IF-ELSE statement, nested if-else, Switch statement, break, exit (), return (), continue, go-to statement.
9. **Iterative statements:** While-loop, do-while loop, for loop, nested loops , difference between iteration and recursion,
10. **Functions:** Built in and User defined, function declaration, definition and function calls, parameter passing, actual and formal argument, call by value and call by reference, recursive functions , command line argument, multifile program.
11. **Arrays:** Linear Arrays(declaration, accessing elements of an array, initialization) multidimensional Arrays, array of strings, passing array to functions.
12. **Structureandunions:**Definition,Declaration,Accessingofelementanduseofstructure,union,enumerated data types and difference between structure and union, arrays of structures, passing structure in to function and passing its element in to function, .
13. **Pointers:** Introduction, Accessing the address of a variable , Declaring &initializing pointers, Accessing a variable though in pointer, pointers &Arrays, Pointers& character strings, pointers & functions.

References:

1. –Computer Fundamentals ‖by V.Rajaraman
2. –Computer Fundamentals ‖by. B. Ram
3. –Programming in C ‖by E. Balagurusamy, TMH.
4. –Let us C‖, by Yashwant kanetkar, Narosa publications.
5. –Schaums outline series‖, by Gottfried, TMH
6. Programming in C by Dennis and Ritche 7.—Magic with C‖ A B Publication

Subject: Basic Electrical Engineering Code: EE-101T Credits: 4 L T P: 3 1 0

UNIT 1: Basic Concept: Definitions & units, Introduction to Basic Laws, Circuit Elements, KVL, KCL, Ideal & Real Sources, Dependent & Independent Sources, Conversion of Voltage Source into Current Source & vice Versa, Controlled and Uncontrolled Sources, Loop and Nodal Method of analysis, Star to Delta Transformation & vice-versa.

UNIT 2: Magnetic Circuit: MMF, Flux, Reluctance, Magnetic Effect of Electrical Current, Hysteresis & Eddy Current Losses.

UNIT 3: Network Theorems: Superposition, Thevenin, Norton, Maximum Power Transfer & Reciprocity Theorems.

UNIT 4: Steady-State Response: Steady-State Response of Circuit to Sinusoidal functions, Phasor Representation of Sinusoids, Concept of Complex Impedance, Series & Parallel AC Circuits, Series & Parallel resonance

UNIT 5: Balanced Three-Phase Circuit: Generation of Three Phase Voltage, Star/Delta Connected Supply, Balanced Load Circuits, Line and Phase Voltage & current Relations. Concept of Three Phase Power.

UNIT 6: Transient: Response of RC, RL & RLC Circuit to DC Excitation only (simple problem).

UNIT 7: Instruments: Introduction to MI, MC Instruments, Extension of range, Dynamometer Type Wattmeter, Simple problems based on these instruments.

Books:

1) Basic Circuit Therory by L.P. Huelsman, PHI.
2) Hughes Electrical Technology by M. Smith, Addison-Wesley Pub
3) Electrical Technology by B.L. Theraja.
4) Electrical Engineering Fundamentals by V. Deltoro, PHI

Subject: Basic Electronics Engg. **Code: EL-101T/102T** **Credits: 4**

Branches: All branches **Sem: I/II Semester** **L T P: 3 1 0**

Course Outcomes; At the end of the course, student will be able to

CO1: Understand the concept of semiconductor physics

CO2: Characterize junctions diode

CO3: Apply the concept of diode in rectifying circuits, filters circuits and DC power supplies

CO4: Understand the application of diode in wave shaping, in voltage multiyear

CO5: Understand fundamental principles of bipolar junction transistors

Unit 1:- Introduction of Semiconductor Physics: Band Theory of solids, Insulator, Semiconductor & Metals, Mobility and Conductivity, Electrons and holes in an intrinsic semiconductor, Carrier concentration in an intrinsic semiconductor, n-type material, p-type material, Donor and Acceptor impurities, Charge densities in a semiconductor, Hall-effect, Diffusion, the continuity equation, Fermi level in a semiconductor having impurities.

Unit 2:- Junction Diode Characteristics: p-n junctions, Forward bias, Reverse bias junction, V-I characteristics, Effect of temperature on a p-n junction diode, Maximum temperature operation, Reverse breakdown voltage, Capacitive effects in a p-n junction diode, Space charge capacitance, Diffusion capacitance, Diode Resistance, Static and Dynamic Resistance, Comparison of practical with ideal diode, load line analysis of a diode circuit.

Unit 3:- Rectifying Circuits and DC Power supplies: p-n junctions as an rectifier, form factor, average voltage and current, haft wave & full wave rectifier, voltage regulation, Ripple factor, Bridge rectifier, Comparison of rectifier circuits, Filter circuits for power supplies, inductor filter, capacitor filter, Effect of capacitor series resistance, Peak inverse voltage of a half wave rectifier, LC filter, Comparison of filter circuits.

Unit 4:- Diode Applications: Clippers, Series and parallel, Clampers, Zener diodes, Zener diode specification, Voltage regulator circuits, Design of a voltage regulator circuits, Effect of supply voltage variations, Zener diode breakdown mechanism, Voltage multiplier circuits, voltage doublers, voltage Tripler, Quadrupoler.

Unit 5:- Bipolar Junction Transistor: The junction transistor, Transistor current components, transistor as an amplifier, Common base configuration. Early effect, the input and output characteristics, Common emitter configuration I/O characteristics, Active, Saturation, Cut-off regions for configurations, common collector configuration, common base current gain, common emitter current gain.

REFERENCES

1. Integrated Electronics: Analog and Digital Circuits and System by Millman, Halkias and Parikh, TMH, Second Edition.
2. Electronic Devices and Circuits, An introduction by Allen Mottershead, TMH.
3. Electronic Devices and Circuits theory by Robert L. Boylestad, Louis Nashelsky.

Basic Mechanical Engineering **ME-105T** **Credit: 04**

L T P (3 1 0)

A. Thermodynamics:

Unit: 1 Fundamental Concepts and definitions: Definition of thermodynamics, system, surrounding and universe, phase, concept of continuum, macroscopic & microscopic point of view. Density, specific volume, pressure, temperature. Thermodynamic equilibrium, property, state, path, process, cyclic process, Energy and its form, work and heat, Enthalpy.

Unit: 2 Zeroth Law: Concepts of temperature, zeroth law.

First Law: First law of thermodynamics. Concept of processes, flow processes and control volume, flow work, steady flow energy equation, Mechanical work in a steady flow of process.

Second Law: Essence of second law, Thermal reservoir, Heat engines. COP of heat pump and refrigerator, Statements of second law. Carnot cycle, Clausius inequality, Concept of Entropy.

Unit: 3 Properties of steam and thermodynamics cycles: Properties of steam, use of property diagram, Steam-Tables, processes involving steam in closed and open systems. Rankine cycle. Introduction to I.C. Engines-two & four stoke S.I. and C.I. engines. Otto cycle, Diesel cycle.

B. Mechanics

Unit: 4 Force system and Analysis:

Basic Concept: Laws of motion. Transfer of force to parallel position. Resultant of planer force system. Free Body Diagrams, Equilibrium and its equation, Centre of gravity, Moment of Inertia.

Friction: Introduction, Laws of coulomb friction, Equilibrium of bodies involving dry friction-Belt Friction.

Unit: 5 Stress and Strain Analysis:

Simple stress and strain: Introduction, Normal shear stresses, stress-strain diagrams for ductile and brittle materials, elastic constants, one dimensional loading of members of varying cross sections, strain Energy.

Unit: 6 Newton's Second Law: D" alemberts Principle-problems (for horizontal & inclined surface). Analysis of lift, motion problem. Motion of several connection bodies, Motion of two bodies connected by as tiring, when one body is lying on horizontal surface and other is hanging free, when one body is lying on inclined plane and other is hanging free case (i) Smooth inclined surface case (ii) Rough inclined surface of co-efficient of friction „μ" (only problems).

Work Power & Energy: work-Units of work-Problems (horizontal & inclined surface). Power Derivation of the expression for power required to drive a body, problems energy, Types of energy problems. Laws of conservation of energy. Newton"s law of conservation of momentum. Plastic impact & Elastic impact. Driving a pile into ground-problems. Motion of connected bodies, work done by spring.

Books:

1) Thermodynamics by P.K. Nag.
2) Thermodynamic by P.L. Ballaney.
3) Engineering Mechanics & Strength of Materials by R.K.Bansal (Chapter 6, 7 & 9) Lakshmi Publications, New Delhi.
4) Holman, J.P.: Thermodynamics, MC Graw Hill book Co. NY.
5) Yadav R.: Thermodynamics and Heat Engines. Vol I & II (SI Edition) Central Publishing House Allahabad.
6) Yadav R.: Steam & Gas Turbines.
7) Engineering Mechanics by S.S. Bhavikatti & K.G. Rajashekarappa (Chapter 9 &
10) New Age Publications, New Delhi
8) F.L. Singer: Strength of Materials.
9) Timoshenko: Strength of Materials.

Subject: Basic Electronics Engg. Lab **Code: EL-101P/102P**
Branches: CSIT, ME, CH (Semester-I); **EC, EI, EE (Semester-II)**

Course outcome; At the end course student s are able to understand
Cos1; understand about Electrical component such as resistance, capacitors and Inductor
Cos2; understand about Bread Board, multimeter, cathode ray oscilloscope and function generator
Cos3; understand about various types of semiconductor devices like diode, BJT transistors
Cos4; understand about half wave and full wave rectifier

List of Experiments

1. To study the Resistance and estimate its value on the basis of color code and Digital Multimeter.
2. To study the Capacitors.
3. To study the Inductors.
4. Study of Bread Board.
5. Study of Multimeter and Tong Tester
6. To study the various types of diodes: Semiconductor diodes, Zener diode & Light emitting diode.
7. To study the Bipolar Junction Transistors.
8. To study the Cathode Ray Oscilloscope (CRO).
9. To study the Function Generator and demonstrate the waveform on CRO.
10. To study the Half-wave rectifier and demonstrate I/P and O/P waveforms.
11. To study the Full-wave rectifier and demonstrate I/P and O/P waveforms.

Note:-

(1) In addition, Department may include more experiments based on the future requirement.

(2) The details of other lab experiments can be taken from concerned departments.

SEMESTER-2

Subject: Engineering Physics-II	**Code: PH-102T**	**Credits: 4**
Branches: All Branches	**Semester: II**	**L T P: 3 1 0**

Dielectric Properties of Materials: Polarization of dielectrics, dielectric constant, electric susceptibility, non-uniform polarization, electric displacement vector, Lorentz local field, Polarizability, Clausius-Mosotti relation, frequency dependence of dielectric constant.

Magnetic Properties of Materials: Magnetization, three magnetic vectors (B.M & H), susceptibility and permeability, Dia, Para, and ferromagnetism, Magnetic domains, hysteresis, Ferro electricity & Piezoelectricity.

Maxwell's Equations: Displacement Current, Maxwell‟s equation in vacuum & medium (Integral and Differential forms), Poynting theorem, Poynting vector.

Electromagnetic Waves: Wave equation, plane waves, Propagation of electromagnetic waves through non-conducting medium, reflection and transmission.

Superconductivity: Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Type I and Type II superconductors, BCS theory (Qualitative), high temperature superconductors. Characteristics of superconductors in superconducting state, applications of superconductors.

Nuclear Physics: Basic properties and constituents of nucleus, mass defect, packing fraction and binding energy, semi empirical mass formula, elementary idea of nuclear forces and their characteristic properties, Nuclear fission, important components and working of nuclear fission reactor, Basic Concept of nuclear fusion reactors.

Books:

1) Electricity and Magnetism: Berkley Physics Course-II.
2) Electromagnetic waves & Radiating systems: Jordan and Keith.
3) Solid State Physics: C. Kittel
4) Nuclear Physics: I. Kaplan
5) Modern Physics: A. Beiser
6) Electrodynamics: D.J. Griffith.

Subject: Engineering Mathematics-II **Code: MA-102T** **Credits: 4**

Branches: All Branches **Semester: II** **LTP: 310**

UNIT: 1 **Numerical Techniques:** Numerical solution of algebraic and transcendental equations by Bisection method, Secant method, Regula-Falsi and Newton-Raphson methods. Numerical integration by Gauss quadrature formula, Trapezoidal rule, Simpson‟s rule and Weddle‟s rule. Numerical solution of ordinary differential equations by Euler‟s method, Milne‟s method and Runge-Kutta method.

UNIT: 2 **Probability and Statistics:** Definitions of probability and simple theorems, conditional probability, Baye‟s Theorem, random variables, discrete and continuous distributions, Binomial, Poisson and normal distributions, correlation and linear regression.

UNIT: 3 **Complex Analysis:** Analytic functions, C-R equations in Cartesian and polar forms, Harmonic functions, Milne-Thomson method, complex integration, Cauchy‟s theorem, Cauchy‟s integral formula. Lioville‟s and Morera‟s Theorems, Taylor‟s and Laurent‟s theorems. Residues: Cauchy‟s residue theorem, evaluation of real integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, do$ and $\int_{-\infty}^{\infty} fen, dx$.

References:

1. E.Balagurusamy: Numerical Methods, Tata McGraw Hill, 2008.
2. Devi Prasad: An introduction to Numerical analysis, Narosa Publishing House, 2006.
3. J.B.Conway: Functions of one complex variable, springer verlag, International Students Edition Narosa Publishing House, 1980.
4. A.M.Goon, M.K.Gupta & B.Das Gupta: Basic Statistics, The world Pren Pvt. Ltd., Calculta, 1991.
5. L.V.Alhfors: Complex analysis, Tata McGraw Hill, 1979.

ME-107T **ENGINEERING GRAPHICS** **(I year: I Sem)**

Credits: 02

L	T	P	Total
1	2	0	02

Unit: 1 Importance of Engineering Drawing, Engineering Drawing Instruments and uses, Layout of Drawing sheet, Lettering and Dimensioning, Types of Lines. Scales: What is scale, Representative factor, Types of Scale: Plain, Diagonal and Vernier scales, Metric Measurements and conventions, Plain Scale, diagonal scale& vernier scale(forward & backward both).

Unit: 2 Conic Section, Definition, and different methods of construction of ellipse, hyperbola and parabola by Eccentricity method Construction of parabola and ellipse by concentric circles method, Oblong method, Parallelogram method.

Unit: 3 Projections, Principle, types and conventions, Theory of Projections and orthographic projections:- Introduction, Types of projections, Orthographic projections, Planes of Projection, Four quadrants, Types of orthographic projections, (a) Projections of point and straight lines, (b) Projections of lines inclined to both the planes, Projection of planes, (a) Projection of solids (b) Projection of solids inclined to both H.P. & V.P. (of prisms pyramids etc).

Unit: 4 Isometric Projections: Theory of isometric projection- Isometric lengths, Isometric scales:- Methods to draw Isometric view or projection, various positions of Isometric axes. Isometric projection with isometric lines, non-isometric lines and with curved & circular surfaces.

Recommended Text Book

1. A Text book of Engineering Drawing (Geometrical Drawing) by R.K. Dhawan
2. Engineering Drawing & Graphics, by K.Venugopal Rao
3. Engineering Drawing by P.S. Gil
4. Engineering Drawing by N. D. Bhatt

Subject: Basic Electronics Engg. **Code: EL-101T/102T** **Credits: 4**

Branches: All branches **Sem: I/II Semester** **L T P: 3 1 0**

Course Outcomes; At the end of the course, student will be able to

CO1: Understand the concept of semiconductor physics

CO2: Characterize junctions diode

CO3: Apply the concept of diode in rectifying circuits, filters circuits and DC power supplies

CO4: Understand the application of diode in wave shaping, in voltage multiyear

CO5: Understand fundamental principles of bipolar junction transistors

Unit 1:- Introduction of Semiconductor Physics: Band Theory of solids, Insulator, Semiconductor & Metals, Mobility and Conductivity, Electrons and holes in an intrinsic semiconductor, Carrier concentration in an intrinsic semiconductor, n-type material, p-type material, Donor and Acceptor impurities, Charge densities in a semiconductor, Hall-effect, Diffusion, the continuity equation, Fermi level in a semiconductor having impurities.

Unit 2:- Junction Diode Characteristics: p-n junctions, Forward bias, Reverse bias junction, V-I characteristics, Effect of temperature on a p-n junction diode, Maximum temperature operation, Reverse breakdown voltage, Capacitive effects in a p-n junction diode, Space charge capacitance, Diffusion capacitance, Diode Resistance, Static and Dynamic Resistance, Comparison of practical with ideal diode, load line analysis of a diode circuit.

Unit 3:- Rectifying Circuits and DC Power supplies: p-n junctions as an rectifier, form factor, average voltage and current, haft wave & full wave rectifier, voltage regulation, Ripple factor, Bridge rectifier, Comparison of rectifier circuits, Filter circuits for power supplies, inductor filter, capacitor filter, Effect of capacitor series resistance, Peak inverse voltage of a half wave rectifier, LC filter, Comparison of filter circuits.

Unit 4:- Diode Applications: Clippers, Series and parallel, Clampers, Zener diodes, Zener diode specification, Voltage regulator circuits, Design of a voltage regulator circuits, Effect of supply voltage variations, Zener diode breakdown mechanism, Voltage multiplier circuits, voltage doublers, voltage Tripler, Quadrupoler.

Unit 5:- Bipolar Junction Transistor: The junction transistor, Transistor current components, transistor as an amplifier, Common base configuration. Early effect, the input and output characteristics, Common emitter configuration I/O characteristics, Active, Saturation, Cut-off regions for configurations, common collector configuration, common base current gain, common emitter current gain.

REFERENCES

1. Integrated Electronics: Analog and Digital Circuits and System by Millman, Halkias and Parikh, TMH, Second Edition.
2. Electronic Devices and Circuits, An introduction by Allen Mottershead, TMH.
3. Electronic Devices and Circuits theory by Robert L. Boylestad, Louis Nashelsky.

Environmental Studies

CY-103T **Credits: 2** **L T P (3 0 0)**

Multidisciplinary nature of environmental studies, Ecosystems, Biodiversity and its conservation, Indicators of environmental pollution, Environment and human health. Consumption of natural resources and environmental degradation of forests, water, coal, minerals, energy, and land. Sustainable development, Environmental policy and legislation, Environmental impact assessment. Pollution of lakes, rivers, ground water, coasts, and oceans, Science and technology for drinking water and wastewater treatment and issues in management of systems. Solid and hazardous waste management: causes, effects and control measures. Air and noise pollution, science and engineering of pollution control, Global Issues including climate change, global warming, acid rain, ozone layer depletion, nuclear hazards, Disaster management, industrial accidents, floods, earthquakes, cyclones and landslides, Grees house effect etc.

Suggested Books

1. W.P. Cunningham and M.A. Cunningham, **Principles of Environmental Science,** Tata McGraw-Hill Publishing Company, New Delhi, 2002.

2. J.A. Nathanson, **Basic Environmental Technology**, Prentice Hall of India, New Delhi, 2002.

3. S.J. Arceivala, and S.R. Asolekar, **Wastewater Treatment for Pollution Control and Reuse** (3rd Edition), Tata McGraw Publishing Co. Ltd., New Delhi, 2006.

4. S.R. Asolekar, and R. Gopichandran, **Preventive Environmental Management: An Indian Perspective**, Foundation Books Pvt. Ltd., New Delhi, 2005. Some selected book-chapters, monographs and journal papers

Fundamentals of Economics

HU-103T **Credits: 2** **LTP (300)**

Microeconomics: What is Economics? Basic economic problems and nature of economics; demand and supply; consumer choice; individual and market demand; production and cost of production; profit maximization and perfect competition; market structure-monopoly, monopsony, monopolistic competition, and oligopoly; externalities and public goods; factor markets-land, labour and capital market.

Macroeconomics: National income accounting-income, expenditure and components of GDP; consumption and saving; investment spending and demand for money; financial systems-central bank, money, credit, financial markets and asset prices; income and spending; money, interest and income; fiscal and monetary policies; economic growth and accumulation; aggregate supply-wages, prices and unemployment; inflation.

Suggested Books:

1. R.S. Pindyck and D.L. Rubinfeld. **Microeconomics** (7th Edition), Pearson Prentice Hall, New Jersey, 2009.
2. R. Dornbusch, S. Fischer, and R. Startz. **Macroeconomics** (9th Edition), McGraw-Hill Inc. New York, 2004.

MANUFACTURING TECHNIQUES **Code: ME-101T** **Credit: 02**
Branch: All **Sem: I** **LTP: 2 0 0**

Unit: 1 Carpentry:-

Wood, timber-exogenous & endogenous, Cross section of an exogenous tree, Seasoning of wood, Seasoning methods, defects (Both natural and that occurs during conversion), Brief description of carpentry tools, various carpentry process. Carpentry joints.

Unit: 2 Pattern & Pattern making:-

Pattern, types of pattern (Single piece, split, Match plate, Sweep, Loose piece, Gated patterns), Pattern making allowances, Design considerations in pattern making, pattern making materials, Core prints.

Unit: 3 Foundry:-

Moulding materials, types of foundry sands; characteristics of foundry sands; Binders & additives; moulding procedures: Floor moulding, Bench moulding, Pit moulding, Machine moulding, Green sand moulding, Dry sand moulding, CO2, Core making processes.

Unit: 4 Foundry' tools & equipments:-

Tools used in foundry (hand tools); moulding machine- (Jolt machine, Squeezing machine, Sand Slinger, Push off machine), Furnaces (Pit furnace, cupola furnace).

Unit: 5 Welding:-

Welding: Pressure and non-pressure, arc welding (AC and DC arc welding, Introduction to Carbon arc welding, metal arc welding, TIG & MIG welding); Electric resistance welding (Spot, seam, projection, But, thermit welding), welding tools and equipments, Gas welding (oxyacetylene).

Unit: 6 Bench work & fitting:-

Tools (holding tools, striking tools, cutting tools), various operations performed in fitting shop (detailed).

Unit: 7 Machine tools: Definition, types.

Lathe specifications; Lathe operations in brief (facing, plain turning, step turning, taper turning, threading, drilling and boring). Milling machine (introduction & brief description of operations only).

Unit: 8 Jigs & Fixture: Introduction, Location points, Basic Design of Jigs & Fixture, Types of Jigs & Fixture.

Text Book:

A text Book on workshop technology by B. S. Raghuvanshi

Reference Book:

Workshop technology by Hazara & Chaudhry,

Production technology by R.K.Jain

Sub: Engineering Physics Lab	**Code: PH-101P**	**Credits: 2**
Branches: All branches	**Sem: I/II Semester**	**L T P: 3 1 0**

List of Experiments

1. To determine the variation of T with l for a compound pendulum (Bar pendulum) and then to determine
(a) The value of **acceleration due to gravity (g)** in the laboratory.**(b) Position of centre of gravity** of the bar and the **(c) The radius of gyration (k)** of the bar about an axis passing through C.G. and perpendicular to its length.

2. To determine the (a) **coefficient of damping (K)** (b**) relaxation time τ**, and (c) **the quality factor Q** of a damped simple harmonic motion using a simple pendulum.

3. To determine the **frequency of A.C. mains** by means of Melde's experiment.

4. To determine the **Young's Modulus of the material** of a given beam supported on two knife-edges and loaded at the middle point, using spherometer arrangement.

5. To determine the **surface tension** of a liquid by a capillary rise method.

6. To determine the **wavelength of sodium light** by Newton's rings.

7. To determine the **wavelength of prominent lines of mercury** by plane diffraction grating.

8. To determine the **specific rotation of cane sugar solution** with the help of a polarimeter.

9. To determine the **dispersive power of the material** of the prism for violet and yellow colours of mercury light with the help of a spectrometer.

10. To study the **V-I characteristics** of **P-N Junction** Diode.

11. To study the **V-I characteristics** of **Zener Diode** and find zener breakdown voltage.

12. To verify the **Stefan's law**.

13. To find the **Planck's constant** by using LEDs of different colours.

14. To find the **energy band gap** of a given material by Four Probe Method.

15. (i) To find the value of **Rydberg constant**.
(ii) To measure the **wavelength of visible spectral lines in Balmer series** of atomic hydrogen.

SEMESTER-3

Subject: Analog Electronics **Code: EL-201T** **Credits: 4**
Branches: EL, CSIT, EE **Sem: III semester** **L T P: 3 1 0**

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

CO1: Analyze simple electronic circuits based on diode and transistor with special focus on designing amplifiers with discrete components

CO2: Design simple linear power supply according to required specifications; analysed biased circuit for BJTs and amplifiers(CE,CB,CC for BJT and FET)

CO3: Perform analysis of AC of amplifiers based on weak signal model (small signal).

CO4: Demonstrate about the feedback effect in amplifier (BJT and FET)

Syllabus

Unit 1:- Transistor as an amplifier: Transistor Biasing and thermal stabilization: The operating point, Biasing Circuits, fixed bias, bias stability, self-bias or emitter bias, fixing of Q-point using graphically & analytical methods, stabilization against variation in I_{CO}, V_{BE}, β: Bias compensation Diode for I_{CO}, V_{BE}.

Unit 2:- The Transistor at low frequencies: Two port devices and the hybrid model. The h-parameter, determination of h-parameter from input and output characteristics. Analysis of a transistor amplifier circuit using h-parameters; the emitter follower (its modelling), miller‟s theorem and its dual, cascading transistor amplifier (up to 2 stages), simplified hybrid model, high input resistance transistor circuit e.g. Darlington, Emitter follower.

Unit 3:- Field effect transistors: General description on FET, JFET operations and its characteristics, MOSFET-N-channel MOSFET, P-channel MOSFET, Drain and Gate Characteristics of MOSFET; the FET small signal model, CS and CD amplifiers at high and low frequencies.

Unit 4:- Feedback amplifiers: Classification of amplifiers, feed back concepts, transfer gain with feedback, general characteristics of negative feedback amplifier, input and output resistances for voltage series, current series, current shunt, voltage shunt feedback, analysis of feedback amplifier (voltage series, current series, current shunt, voltage shunt feedback).

Unit 5:- Power amplifier: Class A large signal amplifier, second harmonic distortion, higher order harmonic generation, the transfer audio power amplifier, efficiency, class B, class C, class AB and push-pull amplifier.

REFERENCES

1. Integrated Electronics Analog and Digital circuits and systems, J. Millman, Halkias and Prikh, TMD.
2. Electronics Devices and Circuit Theory; Robert Boylestad & Nashlasky (PHI).
3. Electronics Devices and Circuit: Allen mottershed (TMH).

Subject: Electronic Measurement & Instrumentation **Code: EL-203T,** **Credits: 4**

Branches: EC, EL **Sem: III Sem.** **L T P: 3 1 0**

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

CO1: To define the performance characteristics and explain the concepts of electrical and electronic instruments used for measuring electrical quantity.

CO2: To understand different types of measuring instruments, their construction, operation and characteristics.

CO3: To apply the different measurement techniques for the measurement of current, voltage, resistance, inductance, capacitance etc.

Unit -1: Measurement & Measurement Systems: Methods of Measurement, Direct and Indirect types of measurement systems; Mechanical, Electrical and Electronic Instruments; Classification of Instruments- Null and Deflection type; Modes of Operation- Analog and Digital. **Characteristics of Instruments:** Static and Dynamic Characteristics, Noise, Linearity, Hysteresis, Threshold, Dead Time & Dead Zone, Input & Output Impedance, Loading Effects due to Shunt Connected Instruments, Loading Effects due to Series Connected Instruments.

Unit-2: Errors in Measurement: Types of static errors-gross errors, systematic errors & random errors; Sources of errors. **Dynamic Response of Instruments & Measuring Systems:** Dynamic response, First order system, Second order system.

Unit-3: Ammeter: DC Ammeter, Multirange Ammeter, Aryton Shunt or Universal Shunt, Requirement of a Shunt, Extending of Ammeter Ranges. **Voltmeter:** DC Voltmeter, Mutirange Voltmeter, Extending Voltmeter Ranges; Digital Voltmeter (DVM)-Ramp type DVM, Dual slope Integrating type DVM, Successive Approximation DVM**. Multimeter:** Introduction, Display (No. of Digit), Range, Resolution, Accuracy; Use of Multimeter as Micro-ammeter, DC Ammeter, DC Voltmeter, AC Voltmeter and Ohmmeter. **Measurement of Power & Wattmeter:** AC & DC Current and Voltage Probes, Power in DC & AC Circuit, Electrodynamometer Wattmeter, Measurement of Power in 3 Phase circuit, 3 Phase Wattmeter, Measurement refractive power.

Unit-4: Bridges: DC Bridge-Wheatstone Bridge, Kelvin Bridge, Measurement of Low & High Resistance; AC Bridge-General equation of bridge balance, General form of AC Bridge, Maxwell's Bridge, Hay's Bridge, Anderson's Bridge, Wein's Bridge, Schering Bridge. **Potentiometers:** DC Basic Circuit, Laboratory type, Standardization of Potentiometers; AC: Drysdale polar potentiometers, Gall-Tinsley AC Potentiometer (Working & Construction both).

Unit-5 :Cathode Ray Oscilloscope (CRO): Block diagram of oscilloscope, Observation of waveform on CRO, Measurement of Phase & Frequency of CRO (Lissajous Patterns). **Waveform Analyzer:** Frequency selective wave analyzer, Heterodyne wave analyzer, Applications of wave analyzers. **Q-Meter:** Principle of working, Circuit of a Q-meter, Applications of Q- Meter.

Reference Books:

1. Electrical & Electronics Measurements and Instrumentation, A K Sawhney, Dhanpat Rai & sons Publication
2. Electronic Instrumentation, H. S. Kalsi, TMH Publication
3. Modern Electronic Instrumentation and Measurement Techniques, Cooper D & A D Helfrick, PHI.
4. Electronic Instrumentation and Measurements, David A Bell, PHI / Pearson Education

CS-203N **Data Structure** **Credits4(3-1-0)**

UNIT 1: Basic Concepts & Notation: Data structure concepts and its types, Linear and Non-Linear data structures. Basics of Complexity and their types;

Array as an ADT: one dimensional array, two dimensional array and multidimensional array.

UNIT 2: Stacks: Definition and examples, primitive operations, Array representation of stacks, Example: Infix, Postfix, and Prefix: Basic definitions and Examples, Evaluating a postfix expression, Converting an expression from infix to postfix, Recursion - tower of Hanoi.

UNIT 3: Queues and Linked Lists: The Queue and its sequential Representation, Priority Queue; Linked Lists: Inserting and removing nodes from the list, Linked list as a data Structure, Other List structures: Circular Lists, Doubly Linked Lists.

UNIT 4: Trees: Binary Trees, Operation on Binary Trees, Traversal: In order, Preorder, Post order; Application Binary Tree. Expression Tree; Binary Tree Representation: Array representation, Link List representation; Example: Huffman Algorithm.
Binary search tree: inserting into Binary Search Tree (BST), Deleting from a BST, Balanced (AVL) Tree, Search Tree and B-Tree.

UNIT5: **Search Methods:** Basic search Techniques: Sequential Searching, Indexed Sequential Search, B++tree.

Sorting: Selection sort, bubble sort, insertion sort, quick sort and Merge sort, Heap sort and their time complexity.
Hashing: Hash function: Division Method, Mid-square Method, Folding Method, hash table, collision resolution: linear probing, chaining.

UNIT 6: Graphs and Their Applications: Introduction, Representation of graphs- Adjacency matrix and adjacency list, Wars hall‘s algorithm, Dijkstra‘s algorithm, Graph traversal: Depth first search, Breadth First search.

Text Books

1. Data Structures using C/C++: Tennenbaum, PHI
2. Introduction to Data tructures: Schaum Series. By Lipetu, Mac Graw Hill
3. Data Structures by Augenstein & Tenenbaum.

Subject: Electromagnetic Theory **Code: EC-203T** **Credits: 4**

Branches: EC, EL **SEM: III Semester** **L P T: 3 1 0**

Unit 1:- Elements of Vector Calculus: Co-ordinate system, differential volume, surface 7 line elements, gradient, divergence, curl and del-operator.

Unit 2:- Review of static electric field: Coulomb's Law, Electric field-intensity, electric flux and flux density, Gauss's Law, conservation properties of electrostatic field, electric potential, Energy and work in electric field, Current, current density and conductor capacitance & dielectric materials, polarization relative permittivity, multiple dielectric capacitors, energy stored in a capacitor.

Unit 3:- Review of magnetic field: Faraday's law, Lenz's law, bio-savart law, Ampere's law, Magnetic flux density, Vector magnetic potential, stokes theorem, magnetic force, Displacement current, self, internal and mutual inductance.

Unit 4:- Maxwell's Laplace's and Poisson's Equation and Boundary condition: Introduction and its applications.

Unit 5:- Electromagnetic waves: Introduction and solutions for partially-conducting perfect dielectric and good conductor mediums, skin depth, interface conditions ate normal incidence, oblique incidence and Snell's laws, perpendicular and parallel polarization, standing wave, power and the pointing vectors.

Unit 6:- Transmission Lines: Wave equation for ideal transmission line, characteristics impedence, propagation & reflection, VSWR, impedance, transformation, smith chart, parallel and co-axial transmission lines, Impedance Matching, single and double stub matching, impedance matching single and double slub matching, impedance measurement, Motion of charged particles in an Electric & Magnetic Field.

REFERENCES

1. Electromagnetic; john D. Kraus TMH
2. Schaum's outline series on Electromagnetic; Joseph A. Edinister , Tata McGraw hill inc.
3. Engineering Electromagnetics; Haytt, Kemmerly.
4. Electromagnetic wave and radiating system; John, Balmin
5. Engineering Electromagnetic; William Haytt

Subject: Network Analysis & Synthesis Code: EE-201T Credits: 4

Branches: EC, EL, EE SEM: III Semester L T P: 3 1 0

Unit 1:- Graph Theory and Network Equation: Introduction, Graph of a Network, Tree, Co-tree; Incidence Matrix, Cut set and Tie-set matrices, Network Equilibrium Equations, Analysis of Network, Duality and Dual Network.

Unit 2:- Fourier Series: Trigonometric and Exponential forms of Non-Sinusoidal functions, Evaluation of Fourier coefficients, Waveform Symmetry, Effective value of a Non-Sinusoidal Wave, Fourier Transform.

Unit 3:- Laplace Transform: Laplace Transform and its applications, Laplace Transformation, basic theorems, Gating function, Laplace Transform of periodic functions, initial value and final value theorems, Solution of network problems.

Unit 4:- Two Port Networks: Open Circuit, Short Circuit parameters, Hybrid and inverse hybrid parameters and interrelation between them, interconnection of two port networks, input output and image impedances.

Unit 5:- Network Function: Network function, Poles and Zeros, necessary conditions for driving points and transfer functions, application of network analysis, Driving network functions, Time domain behaviour from pole zero plot.

Unit 6:- Passive network synthesis: Hurwitz polynomial, positive real functions, LC, RL, R two terminal syntheses.

Unit 7:- Attenuators: Lattice, T-type, π-type, Bridge-T, L-type, Ladder type, balanced type, insertion loss.

Unit 8:- Filters: Filter fundamentals, Constant-k low pairs, Constant-k high pass and constant-k band pass. Band elimination filters m-derived T-section, termination with m-derived half sections, m-derived band pass.

BOOKS

1. Network Analysis by D. Roy Chaudhary, New stage publication.

2. Network Analysis by Van Valkenberg, PHI.

Subject: Engineering Mathematics-III **Code: MA-201T** **Credits: 4**

Branches: All Branches **SEM: III Semester** **L T P: 3 1 0**

UNIT:1 Ordinary Differential Equations:

First order equations (linear and non-linear). Linear equations of second and higher orders with constant and variable coefficients. Solution of second order equations by removing first derivative, changing of dependent and independent variables and method of variation of parameters.

UNIT:2 Special Functions & Partial Diff. Eqns:

Power Series solutions of second order equations by frobenious method. Legendre polynomials and Bessel‟s functions of first kind and their properties. Method of separation of variable for heat, wave and Laplace equations: Their solutions and related applications.

UNIT:3 Integral Transforms:

Laplace transform, existence theorem, Laplace transform of derivatives and integrals, Laplace transform of special functions. Inverse Laplace transform, convolution theorem. Applications of Laplace transform and its inverse to solve ordinary and partial differential equations.

Introduction to Fourier transforms. Fourier series, half range sine and cosine series, related applications.

References:

1. J.N.Sharma: Differential Equations, Krishna Prakashan Media (P) Ltd., Meerut.
2. B.V.Raman: higher Engineering Mathematics, Tata McGraw Hill Co., Ltd., 2008.
3. R.K.Jain& S.R.K. Iyenger: Advance Engineering Mathematics, Narosa Publishing House, 2002.
4. A.R.Vashistha: Integral Transforms KrishanPrakashan Media (P) Ltd., Meerut.
5. G.F.Simmons: Differential Equations, Tata McGraw Hill Co. Ltd., 1981.

Subject: Analog Electronics Lab **Code: EL-201P** **Credits: 2**
Branches: EL, CSIT **Semester: III** **LTP: 003**

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

CO1: Analyze the circuit design process and simulate the common base, common emitter and common collector amplifier circuits
CO2: Analyze and select analog devices using circuit specifications based on circuit requirements
CO3: To study input output characteristic of transistors, filter and rectifier circuits.
CO4: Study effect of biasing and plot the characteristic

List of Experiments

(1) To measure, plot and study the V-I characteristics of semiconductor diode:

(a) Forward bias (b) Reverse bias

(2) To draw the input and output waveforms for the following Rectifier Circuits:

(a) Half-Wave Rectifier Circuit.

(b) Full-Wave Rectifier Circuit.

(c) Filter Circuits.

(3) To study the output characteristics of a NPN Transistor.

(4) To study the output characteristics of a PNP Transistor.

(5) To study the characteristics of N-channel FET.

Note:-
(1) In addition, Department may include more experiments based on the future requirement.

Subject: Electronic Measurement & Instrumentation Lab **Code: EL-203P,** **Credits: 2**

Branches: EL **Sem: III Sem.** **L T P: 0 0 3**

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

CO1: To analyze different measurement devices and its working principles.

CO2: To apply the concepts for the measurement of different parameters such as current, voltage, resistance, inductance, capacitance etc.

CO3: To apply the concept of calibration of a measuring instrument.

List of Experiments:

1. Instrument workshop- Observe the construction of PMMC, Dynamometer, Electrothermal and Rectifier type of instruments, Oscilloscope and Digital multimeter.
2. Calibrate moving iron type ammeter/voltmeter by potentiometer.
3. Measurement of resistance using Kelvin's double bridge.
4. Measurement of power in three phase circuits.
5. Measurement of frequency by Wien's Bridge.
6. Measurement of Inductance by Anderson's Bridge.
7. Measurement of capacitance by Schering Bridge.
8. Measurement of R,L,C & Q using LCR Q meter.

SEMESTER-4

Subject: Linear Integrated Circuits **Subject Code: EL-202T** **Course credit: 04**
Sem.: IV **Branch: EL, EC, EE** **L T P: 3 0 1 0**

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

CO-1: Understand the concepts of various amplifiers, active filters, PLL and Oscillators.
CO-2: Analyze the various electrical parameters of Op-Amp using negative feedback, active filters circuits and oscillators.
CO-3: Design and implementation of op-amp based circuits and active filters.
CO-4: Perform experiments to obtain output of circuits based on 741IC op-amp and presents the results.

Course Pre-requisites: Students should have the basic fundamentals and applicationsof Basics Electronics Engineering, Analog Electronics and Network Analysis.

UNIT -1 : Differential Amplifier-Introduction, Differential amplifier circuit configurations, D.C and A.C analysis of dual input balanced output differential amplifier, Constant current bias circuit, Transistor current mirror and active loads, Level translator stages of op-amp.

UNIT- 2 : Operational Amplifier and its Characteristics Introduction, Block diagram representation of typical op-amp; Electrical parameters like-Input offset voltage, Input offset current, Input bias current, CMRR, Slew rate etc.; The ideal Op-Amp, Equivalent circuit of an Op-Amp, Voltage transfer curve, Open-loop Op-Amp Configurations.

UNIT - 3 : Negative Feedback and Frequency Response of Op-Amp-Block diagram representation of Feedback configurations, Voltage series and Voltage shunt feedback amplifier, Concentrating on Voltage gain, Input and Output resistances, Bandwidth and feedback expressions, voltage follower circuits. Frequency response, Compensating networks, High frequency op-amp equivalent circuit, Open-loop voltage gain as a function of frequency.

UNIT - 4 : Applications of Op-Amp- Summing amplifier, Scaling and averaging amplifier, Instrumentation amplifier, Integrator, Differentiator, Differential amplifier realization using one and two op-amp.

Active Filters, Advantages of active filters over passive filters, First order low pass Butterworth filter design, Second order low pass Butterworth filter, First and second order high pass Butterworth filters, Band pass and band reject filters, All pass filters.

UNIT -5 : Oscillators and Signal Generators- Oscillator Principles, Oscillator Types, Phase Shift Oscillator, Wien Bridge Oscillator, Voltage controlled Oscillator.Basic comparator, Zero crossing detector, Schmitt Trigger, Square wave generator, Triangular wave generator, Introduction to 555 Timer, Monostable and Astable operation of 555 Timer, Phase locked loop.

Text Books:

1. Op-amps and Linear Integrated Circuits by Ramakant A. Gayakwad, PHI, India.

2. Operational amplifiers and linear Integrated circuits by Coughlin and Driscoll-PHI, India.

3. Linear Integrated Circuits by D. Roy Chaudhary, Shail Jain, New Age International (P) Ltd, India.

Subject: Signals and Systems **Code: EC-202 T** **Credits: 4**

Branches: EC, EL **SEM: IV Semester** **L P T: 3 1 0**

Unit 1:- Signals: Introduction, classification of signals, signal energy, signal power, transformations of independent variable, unit step function, unit impulse function, Sampling function, exponential function, even and odd functions.

Systems: Introduction, classification of systems, continuous time LTI systems, convolution integral: Graphical & analytical methods of convolution, Signal comparison: Orthogonality, correlation.

Unit 2:- Continuous time signal analysis:

Fourier Series: Introduction, Fourier series representation of continuous time periodic signals, convergence of Fourier series, properties of continuous time Fourier series.

Fourier Transform: Introduction, representation of continuous time aperiodic signals, properties of Fourier transform, ideal and practical filters, Energy and Power spectral density of signal.

Unit 3:- The Laplace transforms: Introduction, region of convergence, the inverse Laplace transform, properties of Laplace transform, unilateral Laplace transform.

Unit 4:- Sampling: Introduction, sampling theorem, Nyquist rate & Nyquist interval, Recovery from sampled signal, Aliasing, Aperture effect, ideal sampling, natural sampling and flat top sampling.

Unit 5:- Random variables: Introduction, Discrete random variables: conditional probabilities, cumulative distribution function (CDF), Continuous random variables: Probability density function (PDF), Gaussian PDF, Rayleigh density function.

REFERENCES BOOKS

1. Signals and Systems by Alan V. Oppenheim, Alan S. Willsky.
2. Linear Systems and Signals by B.P. lathi
3. Modern Digital and Analog Communication Systems by B.P Lathi
4. Signals and Systems by Simon Haykins
5. Digital communication systems by Taub& Schilling

Subject: Digital Electronic Circuits	**Code: EL-204T**	**Credits: 4**
Branches: EL	**SEM: IV Semester**	**L T P: 3 1 0**

Course outcomes: At the end of the course, the student will have the ability to:

CO1: understand the Boolean algebra and minimization of functions.

CO2: understand the different logic families and their working principle.

CO3: designing the combinational logic circuit with different digital gates.

CO4: designing the Sequential logic circuit with different digital gates.

CO5: designing the different register and counter.

Unit 1:- Basic Concept of Boolean Algebra: Different rules for arithmetic operation, minimization of switching functions with theorem and K-Map up to five variables, reduction techniques, prime and essential implicants, concepts of don‟t care condition, min. and max. Terms SOP, POS variables, entered mapping VEM, plotting & reading theory, QM methods.

Unit 2:- Digital Logic Families: TTL, RTL, DTL, ECL, Totem pole and open collector concept, comparison of logic families.

Unit 3:- Combinational Logic Circuits: Design of combinational logic circuit using different chips/gates. Code converter: BCD-gray, Excess-3, encoders, decoders, multiplexers, de- multiplexers, 7-segment decoder/driver, ROM, PLA, full and half adder/subtractor, parallel adder/subtractor, look ahead carry generator, parity bit checker/generator, Implementation of boolean function with mux and decoder.

Unit 4:- Sequential Logic Circuits: Concept of memory storage, Latches, Flip Flops, JK, SR, T, D, Master slave, characteristic table truth table, concept of flip-flop, conversion techniques, race around condition, Triggering of flip flop, classification of sequential machines, oscillators, analysis of synchronous sequential circuits, design steps for sequential circuits, state diagram, state reduction minimization of the next state decoder, o/p decoder designing.

Unit 5:- Design of Single mode and Multimode Counter: Registers, Shift register, Shift register sequences, Ripple & Ring Counter using shift register and memories type of register universal and directional.

REFERENCES

1. Digital Logic and Computer Design by M. Morris Mano (PHI)
2. Digital Principles and Applications by Malvino & Leach, McGraw-Hill Book Co.
3. Fundamental of Digital Electronics by T.C. Bartee, TMH

Code: CS-204T **Computer Organization** **Credits: 4(3-1-0)**
Branches: EE, EC, EL ,CSIT

1. **Introduction: -** Review of digital logic gates, Design of adder and subtractor using gates &K-MAP.

2. **Arithmetic for Computer:-** Introduction to number system, negative numbers, Arithmetic Algorithms (addition, subtraction, Booth Multiplication), IEEE standard for Floating point numbers

3. **Processor Design:-** Von-Neumann Structure, Processor Organization: General register organization, Stack organization, Addressing modes, instruction types, RISC and CISC.

4. **Control Design: -** Control memory address sequencing, micro instruction interpretation, CPU control unit, Hardwired & Micro Programmed Control Unit, basic concepts of micro programmed control, micro program sequencer for a control memory, micro instruction formats.

5. **Memory Organization:-** Characteristics of memory systems, Memory Hierarchy, Virtual Memory, Dynamic Address Translation Scheme addressing scheme for main memory, TLB, characteristics and principles of cache memory, elements of cache design, Cache memory organization, Block replacement policies and mapping techniques.

6. **System Organization: -** Synchronous & asynchronous communication, standard communication interfaces, Bus arbitration (Serial and Parallel procedure), Modes of transfer, Programmed I/O (IO addressing, IO instruction), DMA (Cycle Stealing Concept, DMA Controller and DMA Transfer), interrupt driven I/O: Interrupt processing, interrupt hardware, types of interrupts and exceptions. **REFERENCES**

1. Computer Architecture and Organization, By John P. Hayes, TMH.
2. Computer organization and design, by John L. Hennessy & David A. Petterson, organ Kaufman.
3. Computer System Architecture, by M. Morris Mano, PHI
4. Computer Organization, Stallings(PHI)
5. Structured Computer Organization, Tannenbaum (PHI)

Code : EL-206T Solid State Materials and Devices Credits 3 1 0

Unit 1

Energy Bands and Charge Carriers in Semiconductors- Energy-band (E-k) diagram, effective mass, wave vector, Debye length, Direct & indirect band-gap semiconductors; Carrier distribution, Fermi-level, Intrinsic & Extrinsic semiconductors, Non-equilibrium in carrier distribution; drift, diffusion, scattering; Piezo & Hall effects.

Unit 2

Rectifier and detector diodes: P-N junction & Schottky junction physics, I-V relation, Junction capacitances, Diode switching, Optical devices & Solar cells, Tunnel diode.

Unit 3

Bipolar Junction Transistors*:* Physical mechanism, current gain, minority current distribution; Punch-through and avalanche effect; High voltage and high power transistors; Frequency limitations, high frequency transistors, Power transistors.

Unit 4

Field Effect Transistors: JFETS, IJFETS and MOSFETs; MOS-Capacitors, flat band and threshold voltages; P and N-channel MOSFETS, CMOS and VLSI MOSFETS, Semiconductor sensors and detectors.

Text Books :

1. Neamen- Semiconductor hysics and Devices TMH
2. Bhattacharya & Sharma- Solid State Electronic Devices- Oxford Maini & Agrawal- Electronics Devices and Circuits- Wiley
3. Streetman, Ben G., and Sanjay Banerjee. Solid state electronic devices. Vol. 4. New Jersey: Prentice hall, 2000.

Subject: Human Values and Professional Ethics **Code: HU-204T** **Credits: 2**

Branches: All Branches **SEM: IV Semester** ***L T P*: 2 0 0**

Unit 1: Understanding Education:

Dialogues on education, to reflect over meaning and significance of education. History and philosophy of education, Search for truth and understanding of cosmos and society. - Pre industrialization and post industrialization. Modern education, a process of alienation from self and society. - Critique of education from the Western and Indian perspectives

Unit 2: Indian Perspectives of Education:

Notions of Vidya, Shiksha, Talim and Education. Upanishads and Raj-Yoga for understanding and educating the Self. - Spirit of enquiry of the Upanishads and the path of Ashtanga Yoga. Role of education in transforming social consciousness. Alternatives in education in 19th-20th century India.

Unit 3: Harmony in nature:

Four orders of nature- material order, plant order, animal order and human order. Salient features of each. Human being as cause of imbalance in nature. (Film "Home" can be used.). Human being as cause of imbalance in nature. Depletion of resources- water, food, mineral resources. Pollution, Role of technology, Mutual enrichment not just recycling. Prosperity arising out of material goods and understanding of self. Seperation of needs of the self and needs of the body. Right utilization of resources. Understanding the purpose they try to fulfil.

Unit 4: Recapitulation on society:

Five major dimensions of human society. Fulfilment of the individual as major goal. Justice in society. Equality in human relationships as naturally acceptable. Establishment of society with abhaya (absence of fear).

Unit 5: Ethics:

Ethical Human Conduct, Value, Character and Netikataa. Professional ethics, conduct as an engineer or scientist. Holistic human being through holistic education in just order.

Subject: Linear Integrated Circuit Lab	**Code: EL-206P**	**Credits: 2**
ranches: EC, EL and EE	**SEM: IV**	**L T P:0 0 3**

Course outcomes: At the end of the Lab, student will be able to:

CO1: Work in a team to demonstrate various application of IC 741 OP-AMP.

CO2: Investigate the response of a given op-amp (IC 741) based circuits for standard input signals.

CO3: Present the observations made by their team in record while avoiding plagiarism

List of Experiments

1. To perform the op-amp based Inverting amplifier.
2. To perform the op-amp based Non-Inverting Amplifier.
3. To perform the op-amp based Voltage follower amplifier.
4. To perform the op-amp based Adder.
5. To perform the op-amp based Subtractor.
6. To perform the op-amp based Integrator circuit.
7. To perform the op-amp based Differentiator circuit
8. To perform the op-amp based Comparator circuit.

Subject: Digital Electronic Circuit Lab	**Code: EL-204P**	**Credits: 2**
Branches: EL	**SEM: IV Semester**	**L T P: 0 0 3**

Course outcomes: At the end of the Lab, the student will have the ability to:

CO1: Design the Boolean algebra and minimization of functions.

CO2: Design the different logic families and their working principle.

CO3: Design the combinational logic circuit with Binary and BCD Adder/ Subtractor, multiplexers/Demultiplexers.

CO4: Designing the Sequential logic circuit with different digital gates.

List of Experiments

1. To verify the truth table of logic gates.
2. Realization of Boolean functions using various logic gate ICs.
3. To study application of IC 7483 binary addition/subtraction and BCD addition/subtraction.
4. To study the functions of multiplexers, Demultiplexers and decoder.
5. To study the various types of flip-flops using NAND gates.

Note:-

(1) In addition, Department may include more experiments based on the future requirement.

(2) **The details of other lab experiments can be taken from concerned departments.**

Subject: Python Programming Lab	**Code: EL-208P**	**Credits: 2**
Branches: EL	**SEM: IV Semester**	**L T P: 0 0 3**

List of Experiments

1. Introduction to python programming
2. To compute the GCD of two numbers using python
3. To find square root of number
4. To find exponential using python programming
5. To find the maximum of list of numbers
6. To find a value using linear search in python program
7. To find a value using binary search in python program
8. To sort list of elements using selection sort
9. Write a program to find prime number
10. To multiply matrices using python
11. To sort list of elements using insertion sort
12. To sort list of elements using merge sort
13. To find word and lines in command line arguments

SEMESTER -5

Subject: Analog Communication System **Code: EC-301T** **Credits: 4**

Branches: EC, EL **SEM: V Semester** **L P T: 3 1 0**

Unit 1:- Introduction to Analog communication

Review of Signals and Systems: Baseband Signals, Band pass Signals, LPF,HPF, BPF. Fourier series representation of periodic signals. Frequency spectrum of sinusoidal signals. Need for modulation, Block diagram of Analog Communication system, Frequency Division Multiplexing. Definitions of Amplitude Modulation, Frequency Modulation and Phase Modulation.

Unit 2:-Amplitude Modulation

DSBFC: Time domain and frequency domain description single tone modulation, power relations in AM waves, Generation of AM waves: square law Modulator, Switching modulator. Detection of AM Waves: Square law detector, Envelope detector. Double side band suppressed carrier modulation: Time domain and Frequency domain description, Generation of DSBSC Waves, Balanced Modulators, Ring Modulator, Coherent detection of DSB-SC Modulated waves. Single side band Suppressed carrier modulation: Introduction to Hilbert Transform, Frequency domain description, Frequency discrimination method for generation of AM SSB Modulated Wave, Time domain description, Phase discrimination method for generating AM SSB Modulated waves. Demodulation of SSB Waves. Introduction to VSB. Comparison of AM Techniques, Applications of different AM Systems.

Unit 3:- Angle Modulation

Basic concepts, Phase Modulation, Frequency Modulation, and Relation between them. Spectrum Analysis of Sinusoidal FM Wave (Single Tone): Narrow band FM, Wide band FM, Transmission bandwidth of FM Wave, Comparison of FM & AM. Generation of FM Waves: Direct Method: Varactor Diode, Reactance Modulator. Indirect Method: Armstrong Method, Commercial FM transmitter block diagram and explanation of each block. Detection of FM Waves: Balanced Frequency discriminator, Phase locked loop, Foster Seeley Discriminator, Ratio detector.

Unit 4:- Receivers and Noise

Radio Receiver: Characteristics of receiver, Types of Receiver: Tuned radio frequency receiver, Super-heterodyne receiver. Noise: Sources of Noise, Models of Noise: AWGN, Impulse Noise. Noise in AM Receivers: using coherent detection, using Envelope detection. Noise in FM receivers. Pre-emphasis and De-emphasis.

Unit 5:- Pulse Modulation

Sampling Process, Pulse Amplitude modulation, Pulse Width Modulation and Pulse Position Modulation. Pulse Code Modulation, Differential Pulse code Modulation. Delta Modulation and Adaptive Delta Modulation. Time Division Multiplexing.

Text Book:

1. **George Kennedy** and **Bernard Davis, "Electronic Communication Systems",** TMH Edu Pvt. Ltd.
2. **Simon Haykin, "Communication Systems"**John Wiley& Sons Inc**.**
3. **Herbert Taub**and **Donald L. Schilling, "Principles of Communication Systems",**Tata McGraw Hill Publication.

Subject: Microprocessor & Their Applications **Code: EL-301T** **Credits: 4**
Branches: EC, EL, EE and CSIT **SEM: V Semester** **L T P: 3 1 0**

Course outcomes: At the end of the course, the student will have the ability to:

CO1: Describe the general architecture of 8085 microprocessor system and its memory organization.
CO2: Explore and categorize the instruction sets; and assembly language programming of 8085 by the use of different instructions.
CO3: Differentiate between various types of Interrupts and processes.
CO4: Understand and realize the Interfacing of various I/O devices with 8085 microprocessor and their use in industrial and non-industrial applications.
CO5: Understand the advance microprocessor and different communication standards.

Unit 1:- General features and Architecture of 8085 Microprocessor: Microprocessor architecture and its operation, Memory, Memory Organisation, Memory Mapped I/O mapped I/O Scheme, 8085 Microprocessor pin configuration, Internal architecture and its operation, Control signals, Flag register, Timing control unit, Decoding, Execution of an instructions and memory interfacing. Timing instruction cycle, Opcode Fetch, memory and input output read/write cycle of an instruction set.

Unit 2:- Programming Techniques of 8085 Microprocessor: How to write and execute a simple program timing and execution of the instructions, Addressing modes, programming techniques, programming technique for looping, counting and indexing, counter programs and timing delay program and timing calculations, stack operation and subroutine programs.

Unit 3:- Interrupts of 8085 Microprocessor: Hardware and software interrupts, interrupts call locations, RIM, SIM, RST 7.5, 6.5 and 5.5.

Unit 4:- Programmable interfaces of 8085 microprocessor and its Applications: Programmable peripheral interface 8255, programmable interval timer 8253/8254, DMA controller 8257, and interrupt controller 8259, Delay subroutine, seven segment display, water level indicator, microprocessor based traffic control.

Unit 5:- Introduction to 8086, other advance microprocessors and various IEEE communication standards: Internal Architecture organisation, Maximum mode and minimum mode, instruction set, initialization instructions, constructing the machine codes for 8086 instruction. Assembler directives, addressing modes, procedure and macros, re- entrant and recursive procedures, 8087 Coprocessor: Features and internal organization, Features and architecture of 80186, 80286, 80386 & 80486, RS-232, RS-442, IEEE-488.

REFERENCE BOOKS:

1. Microprocessor Architecture programming and application with 8085/8080 by Ramesh S. Gaonkar.
2. Fundamentals of Microprocessor & Microcontroller by B. Ram.
3. Microprocessor and interfacing Programming and Hardware by Douglas V. Hall.
4. The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386 80486, Pentium and Pentium pro-processor, Architecture, Programming and interfacing by Berry b. Bery.

Subject: Sensors and Transducer	**Code: EL-303T**	**Credits: 4**
Branches: EL	**Semester: V**	**L T P: 3 1 0**

Course outcomes: At the end of the course, the student will have the ability to:

CO1: understand the different types of transducers and its Characteristics.

CO2: understand the working principle of Miscellaneous Transducers.

CO3: understand the requirement and concept of Signal Conditioning and Data Acquisition Systems.

CO4: understand the different types of Data Transmission & Telemetry system with data Display and Recorders

Unit 1:- Introduction of Transducer: Definition, Transducers, Sensors and Actuators, transducer as a function of instrumentation system, Classification of transducers-active and passive, primary and secondary, Inverse Transducers, electrical transducers and their advantages, typical example of transducer element.

Characteristics and selection of transducers:-Input characteristics-type of input and operating range, transfer characteristics-transfer function, Output characteristics-type of electrical output, output impedance and useful range, selection criteria of transducers, typical specification of a transducer system.

Unit 2:- Resistive, Inductive and Capacitive Transducers: Resistive Transducers- Linear and nonlinear potentiometers, materials used, advantages and disadvantages of resistive transducers; Strain gauge principle and types-bonded, unbounded, semiconductor strain gauge. Inductance Transducer- Introduction, principle of working, change of self induction, change of mutual induction and production of eddy currents. LVDT-construction, principle, advantages, disadvantages and uses. Capacitive Transducer- Introduction, principle of working, change in area of plates, change in distance between two plates and variation of two plates. Nonlinearity in capacitive transducers and differential arrangements, frequency response, advantages, disadvantages and uses.

Unit 3:- Miscellaneous Transducers: Digital Transducer- Introduction, types of digital encoding transducers, classification of encoders-Tachometer, incremental and absolute. Piezoelectric transducer-Principle, operation, equivalent circuit, loading effect, frequency response and uses. Hall Effect Transducer- Construction, Principle and uses. Optoelectronic Transducer- Photovoltaic cell and its application, photoconductive cell and semiconducting photodiode.

Unit 4:- Signal Conditioning and Data Acquisition Systems: Types of signal conditioning- DC and AC, Analog and Digital data acquisition system, single and multi-channel data acquisition systems. Components of data acquisition systems use of data acquisition systems.

Unit 5:- Data Transmission & Telemetry, Display and Recorders: Introduction of telemetry, general telemetry system, Landline Telemetry-voltage telemetry system, current telemetry system, position telemetry system and feedback telemetry system; RF (Radio frequency) Telemetry System-general modulation methods (AM, FM) comparison between AM & FM, Pulse modulation, Pulse amplitude modulation and pulse code modulation telemetry systems, Transmission channel and media-wire line and radio link. Analog displays & recorders, digital recorders, digital displays, digital printers, barcode.

Reference Books

1. Electrical & Electronic Measurement & Instrumentation by A.K. Swahney
2. Telemetry Principle, D Patranabis; TMH Ed-1, 1999

Subject: Antenna Engineering	**Code: EL-305T**	**Credits: 4**
Branches: EL	**Semester: V**	**L T P: 3 1 0**

Course Contents:

Unit 1

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.

Unit 2

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 circularapertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.

Unit 3

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

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

Unit 4

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

Subject: Control Systems ***Code: EE-301T*** ***Credits: 4***

Branches: EI, EC and EE ***SEM: V Semester*** ***L T P: 3 1 0***

Unit 1:- Introduction:- Basic components of a control system, open loop & closed loop systems.

Unit 2:- Feedback Control System:- Principle of feedback, Transfer function, block Diagram and its Reduction Techniques, Signal flow graph, Effect of feedback on parameters variations and disturbance signal.

Unit 3:- Mathematical Modelling of physical System:- Modelling of translation and rotation mechanical systems, electrical systems, transfer function of these systems.

Unit 4:- Time Response Analysis:- Time response of first & second order systems, steady-state errors, and error constant, Time domain specifications of second order systems. Basic concepts of P, PD, PI, PID controllers.

Unit 5:- Stability:- Basic concepts, BIBO stability, asymptotic stability, Routh-Hurwitz Criterion.

Unit 6:- Root Locus Techniques: - Basic properties & construction of root loci.

Unit 7:- Frequency domain specification:- Frequency domain specification, Bode plots, Polar plots, Nyquist stability criterion, Gain & Phase Margins, M & N-circles, Nichols chart.

Unit 8:- Compensator Design:- Basic concepts of lag, lead & lag-lead compensators.

BOOKS

1. Control System Engineering by Nagrath & Gopal (New Age)
2. Modern Control Engineering by K. Ogata (PHI)
3. Automatic Control System by B.C. Kuo, PHI

Subject: Analog Communication Lab ***Code: EC-301P*** ***Credits: 2***

Branches: EC, EL ***SEM: V Semester*** ***L T P: 003***

1. To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands.
2. To study amplitude demodulation by linear diode detector
3. To study frequency modulation and determine its modulation factor
4. To study sampling and reconstruction of Pulse Amplitude modulation system.
5. To study Pulse Width Modulation and Pulse Position Modulation.
6. To construct a triangular wave with the help of Fundamental Frequency and its Harmonic component.
7. To construct a Square wave with the help of Fundamental Frequency and its Harmonic component.
8. Study of Pulse code modulation (PCM) and its demodulation using Bread Board.
9. Study of Amplitude shift keying modulator and demodulator.
10. Study of Frequency shift keying modulator and demodulator.
11. Study of Phase shift keying modulator and demodulator.

Note:-In addition, Institutes may include more experiments based on the expertise

Subject: Microprocessor Lab	**Code: EL-301P**	**Credits: 2**
Branches: EC, EL, EE, and CSIT	**SEM: V Semester**	**L T P: 0 0 3**

Course outcomes: At the end of this lab, the student will have the ability to:

CO1: understand the general architecture of 8085 microprocessor system and its memory organization.
CO2: explore and practice of various instructions and assembly language programming model of 8085.
CO3: practice of arithmetical and logical operations with assembly language program.
CO4: practice of interfacing of I/P and O/P peripherals with the help of assembly language program.
CO5: practice and implementation of various applications by using 8085 programming models.

1. Study of SDK -85 microprocessor trainer kit.
2. Study of the instructions set of the 8085 microprocessor.
3. Perform the basic logical/ arithmetic and data transfer operation.
4. WAP to add two 8-bits hexadecimal numbers and store the carry at given location.
5. WAP to add two 16-bits hexadecimal numbers and store the carry at given location.
6. WAP to add two BCD numbers of 8-bits.
7. WAP to perform subtraction of two 8-bits hexadecimal numbers.
8. WAP to perform multiplication of two hexadecimal numbers by addition method.
9. WAP to perform multiplication of two hexadecimal numbers by partial product method.
10. WAP to perform division of two hexadecimal numbers by subtraction method.
11. WAP to find a maximum number from a block of Data of 8-bites long.
12. WAP to find a minimum number from a block of Data of 8-bites long.
13. WAP to find number of ones "1" and number of zeros "0" in an 8-bit data.
14. WAP to sort block of Data of 8-bytes long in ascending order.
15. WAP to sort block of Data of 8-bytes long in descending order.
16. WAP to find factorial of number.
17. WAP to move / shift a block of Data of 8-bytes long to five location upward.
18. WAP to move /shift a block of Data of 8-bytes long to five location downward.
19. WAP to interface 8-bit ADC with microprocessor through 8255.
20. WAP to interface 8-bit DAC with microprocessor through 8255.
21. WAP to interface traffic light control model with microprocessor through 8255.

Note:-In addition, Institutes may include two more experiments based on the expertise

Subject: Sensors and Transducer Lab	**Code: EL-303P**	**Credits: 2**
Branches: EL	**Semester: V**	**L T P: 0 0 3**

Course outcomes: At the end of the Lab, the student will have the ability to:

CO1: Understand the measurement of speed using magnetic Pick-up Photo-reflective transducer.

CO2: Understand the measurement of angular displacement using different transducer

CO3: Understand the Strain Gauge.

CO4: Understand the measurement of electrical component R, L and C using LCR meter

LIST OF EXPERIMENTS

1. Study of LVDT.
2. Measurement of Speed using magnetic Pick-up Transducer and verify the result by Tachometer.
3. Measurement of Speed using Photo-reflective Transducer and verify the result by Tachometer.
4. Measurement of Angular Displacement using capacitive and resistive Transducer.
5. Study of Strain Gauge.
6. Measurement of Known and Unknown Inductance, Capacitance and Resistance using LCR meter.

Note:-In addition, Institutes may include more experiments based on the expertise

Subject: Instrumentation and Analysis Lab	**Code: EL-307P**	**Credits: 2**
Branches: CH	**Semester: V**	**L T P: 0 0 3**

Course outcomes: At the end of the Lab, the student will have the ability to:

CO1: Understand the measurement of Temperature.
CO2: Understand the measurement of Pressure.
CO3: Understand the measurement of Flow.
CO4: Understand the measurement of pH, TDS and Conductivity of liquid .

LIST OF EXPERIMENTS

1. Study of Temperature Transducers
2. Study of Pressure Transducer
3. Study of Flow meter
4. Study of pH meter
5. Study of Conductivity meter
6. Study of TDS meter.

Note:-In addition, Institutes may include more experiments based on the expertise

SEMESTER -6

Subject: Digital signal processing **Code: EC-302T** **Credits: 4**

Branches: EL, EC **SEM: VI Semester** **L P T: 3 1 0**

Unit-1 Discrete Time Signals & Systems: Basic discrete time signals, Basic operations on discrete time signals, Classifications of discrete time signals, Discrete time systems and its properties, Analysis of discrete time LTI systems, Techniques for the Analysis of LTI Systems.

Unit-2 The Z- Transform: The Z-transform, Region of convergence and its properties, Properties of Z-transform, Inversion of Z-transform, One sided Z-transform.

Unit-3 Discrete Fourier Transform and it's efficient computations: Discrete Fourier Transform, Its advantages & applications, properties of Discrete Fourier Transform, linear filtering methods based on DFT, Fast Fourier Transform, Its advantages & applications, FFT algorithms(Radix-2 & Radix-4 FFT algorithim), Application of FFT algorithms.

Unit-4 Implementation of Discrete Time system (Filters):

Structure Realization of Discrete time FIR Filters : Direct Form, cascade Form Structure, Linear Phase and Lattice structure Realization.

Structure Realization of Discrete time IIR Filters: Direct Form-I, II, cascade Form Structure, Parallel Form Structure, Transposed Direct Form Realization(Signal Flow Graph) Lattice & Lattice Ladder structure Realization.

Unit-5 Design of Discrete Time system (Filters):

Design of FIR Filter: Design of Symmetric & Asymmetric FIR Filters, Design of FIR Differentiators, Design Linear Phase FIR filters using (Fourier Series Method, Rectangular Window Method, Frequency Sampling Method).

Design of IIR Filter: Design of Low pass & High pass Digital Butterworth Filter, Low pass & High pass Digital Chebyshev Filter using Impulse Invariance Transform Method, Bilinear Transform Method.

REFERENCE BOOKS

1. Digital signal processing (principles, algorithms and applications) by John G. Proakis & Dimitris G. Manolakis, PHI
2. Digital signal processing by Alan V. Oppenheim and Ronal W. Schafer.
3. Introduction to Digital System Processing by Roman Kook., McGraw hill international editions.

Subject: Embedded Systems	**Code: EL-302T**	**Credits: 4**
Branches: EC, EL	**SEM: VI**	**L P T: 3 1 0**

COURSE OUTCOMES: Upon completion of the subject students will be able to:

CO1: Describe internal architecture and operation of microcontroller 8051 and understand the role of embedded system

CO2: Develop assembly language programs using instruction set of 8051

CO3: Understand the interfacing of different peripheral devices with Microcontrollers.

CO4: Understand the design and application of advanced microcontroller and their role in embedded systems.

CO5: Explain IoT systems and the technology behind them.

Unit 1:-Introduction to Microcontrollers and Embedded Systems: Basic architecture of 8051, overview of the 8051 family, Pin description, input-output port and their functions, Memory organization. An introduction to embedded system, classification of embedded systems,

Unit 2:- Instruction Sets and Programming of 8051 Microcontrollers: Instruction set, Address modes, Assemblers and Compilers, 8051 assembly language programming, 8051 timer programming, Basic registers of the Timer and programming in different modes, 8051 Counters programming, basic registers of the counters and programming in different modes, serial port programming.

Unit 3:- Real world interfacing of 8051 with: LCD, push button and Relay, keyboard, ADC and DAC, Stepper motor.

Unit 4:- Introduction to Advanced Microcontrollers: Introduction and Architecture of PIC, ARM, AVR and AT 89C2051 Microcontroller.

Unit 5:- Introduction to IoT: Architectural Overview of IoT, Design principles and needed capabilities, IoT Applications, IoT Technology Fundamentals- Devices and gateways, Role of Cloud in IoT

.**Recommended Books**

1. The 8051 Microcontroller and Embedded System-M.A. Mazidi, Pearson Education.
2. Microcontrollers-A.J. Ayala, Penram International Publishing (1) Pvt. Ltd.
3. 8051 Microcontroller-I. Scott Mackenzie.
4. Microcomputer systems, The 8086/8088 family-Liu & Gibson, prentice Hall of India.
5. The 8086/8088 Family-Design, programming and interfacing-John Uffenbeck-Prentice Hall of India.
6. Microprocessor Architecture, programming and applications with 8085-R.K. Gaonkar, New Age International Publishers.

Subject: Digital Communication System	**Code: EC-304 T**	**Credits: 4**
Branches: EC, EL	**SEM: VI Semester**	**L T P: 3 1 0**

Unit 1:- Motivation for Digital Communication, digital transmission of Analog signals, line coding, bandwidth of digital data, Bit rate, likelihood, prior and posterior probabilities. MAP rule, Maximum likelihood rule.

Unit 2:- Digital Modulation Techniques, BPSK, BFSK, ASK, DPSK, QPSK, Transmitter & Receiver Probability of error of Different Modulation Techniques, M-array modulation Schemes and constellation diagrams.

Unit 3:- Data Transmission, Different Signals, Integrator Response, Optimum filter and matched filter, transfer functions calculation, Probability of error calculation for matched filter, correlation reception of signals, Noise calculation in PCM & DM Systems.

Unit 4:- Information Theory, Absolute & conditional Joint entropy schemes rate of information mutual information, Noise free channel, channel with independent input & output channel capacity, Binary symmetric channel, BEC channel, reception of signals, Shannon Hartley Theorem, capacity of Gaussian channel, BW S/N trade off,

Unit 5:- Coding techniques, coding efficiency, Binary, Shannon Fanon, Huffinan coding error control code, Block codes, Linear block code, hamming distance, error correcting code, cyclic code, convolution codes.

Text Book:

1. **Herbert Taub**and **Donald L. Schilling, "Principles of Communication Systems",**Tata McGraw Hill Publication.
2. **B.P.Lathi,"Modern Digital and Analog Communication Systems",** Oxford UniversityPress.
3. **John G. Proakis, "Digital Communications",** McGraw-Hill Education.

Subject: VLSI Design **Code: EL-304T** **Credits: 4**

Branches: EL **SEM: VI Semester** **L T P: 3 1 0**

Unit 1

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.

Unit 2

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;

Unit 3

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,

Unit 4

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

Unit 5

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

Text Book/ Reference Books

1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.
2. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley,1979.
3. S. M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, MH, 2002
4. J. M. Rabaey, A. P. Chandrakasan and B. Nikolic, Digital Integrated Circuits : A Design Perspective, Second Edition, PHI /Pearson, 2003.
5. R. J. Baker, H. W. Li and D. E. Boyce, CMOS Circuit Design, Layout and Simulation, PH, 1997.

Subject: RF & Microwave Engineering **Code: EL-306T** **Credits: 4**
Branches: EL **Semester: VI** **L T P: 3 1 0**

Unit 1

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.

Unit 2

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.

Unit 3

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.

Unit 4

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.

Unit 5

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.

Unit 6

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.

Subject: Technical Writing	**Code: EL-308T**	**Credits 1**
Branches: EL	**Sem: VI**	**L T P: 1 0 0**

Unit I

Writing Styles -- Expository, Explanatory, Descriptive, Argumentative and Narrative.
Precis writing, Visual Aids in Technical Writing, Plagiarism and Language Sensitivity in Technical Writing, Dialogue Writing, Proposals: Purpose and Types.

Unit 2

Letters at the Workplace—letter writing: Request, Sales, Enquiry, Order and Complaint.
Job Application---Resume and Cover letter, Difference between Resume and CV, Preparation for Interview.
Meeting Documentation--- Notice, Memorandum, Circular, Agenda, Office Order and Minutes of meeting, Writing Instructions.

Unit 3

Ethics and Personality Development-----The Role of Ethics in Business Communication—Ethical Principles, Time Management, Self-Analysis through SWOT and JOHARI Window, Emotional Intelligence and Leadership Skills, Team Building, Career Planning, Self Esteem.

Textbook/ References:

1. Meenakshi Raman and Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press, New Delhi (2015).
2. Sanjay Kumar and Pushp Lata, Communication Skills, Oxford University Press, New Delhi (2015).
3. Herta A Murphy, Herbert W Hildebrandt, Jane P Thomas, Effective Business Communication, Tata McGraw-Hill, Hill Publishing Company Limited, Seventh Edition.

Subject: Embedded Systems Lab **Code: EL-302P** **Credits: 2**

Branches: EC, EL **SEM: VI Semester** **L T P: 0 0 3**

COURSE OUTCOMES: During this lab course, students can learn to:

CO1: Apply the fundamentals of assembly level programming of microcontroller.

CO2: Perform and demonstrate arithmetic operations using assembly language programming using Keil assembler.

CO3: Execute and Demonstrate logical operations using assembly language programming using Keil assembler.

CO4: Perform and demonstrate string instructions using assembly language programming

CO5: Demonstrate sorting operations and using assembly language programming

CO6: Understand the importance of different peripheral devices & their interfacing to 8051

LIST OF EXPERIMENTS

1. Familiarization with 8051 microcontroller board and Its Interfacing cards.
2. Write a program to add two 8 bit number using 8051 microcontroller.
3. Write a program to subtract two 8 bit number using 8051 microcontroller.
4. Write a program to multiplies two 8 bit number using 8051 microcontroller.
5. Write a program to divide two 8 bit number using 8051 microcontroller.
6. Write a program for up counter 0-9 and display it on seven segment display using 8051 microcontroller.
7. Write a program for down counter from 9-0 using 8051 microcontroller and display it on seven segment display.
8. Interface LCD display with 8051 board and display any character.
9. Interface LCD display with 8051 board and write program to display string HELLO WORD.
10. Interface seven segment board with 8051 board and display any alphanumeric character.
11. Write a program to move stepper motor in clock wise direction using 8051 microcontroller.
12. Write a program to move stepper motor in anti clock wise direction using 8051 Microcontroller.
13. Write a program to read analog voltage using parallel ADC USING 8051 microcontroller.

Note:-In addition, Institutes may include more experiments based on the expertise

Subject: Digital Communication Lab ***Code: EC-304P*** ***Credits: 2***

Branches: EC, EL ***SEM: VI Semester*** ***L T P:0 0 3***

1. To construct a triangular wave with the help of Fundamental Frequency and its Harmonic component.
2. To construct a Square wave with the help of Fundamental Frequency and its Harmonic component.
3. Study of Pulse code modulation (PCM) and its demodulation using Bread Board.
4. Study of delta modulation and demodulation and observe effect of slope overload.
5. Study of pulse data coding techniques for NRZ formats.
6. Study of Data decoding techniques for NRZ formats.
7. Study of Manchester coding and Decoding.
8. Study of Amplitude shift keying modulator and demodulator.
9. Study of Frequency shift keying modulator and demodulator.
10. Study of Phase shift keying modulator and demodulator
11 Study of single bit error detection and correction using Hamming code.

12 Measuring the input impedance and Attenuation of a given Transmission Line

Note:-In addition, Institutes may include more experiments based on the expertise

Subject: Product Design Lab	**Code: EL-304P**	**Credits: 2**
Branches: EL	**SEM: VI**	**L T P: 003**

Course outcomes: At the end of the Lab, the student will have the ability to:

CO1: understand the electrical and electronics component.

CO2: understand the fabrication of PCB.

CO3: design and fabrication of the electronics product.

CO4: understand the troubleshooting of hardware circuit.

Objective: To create interest in Hardware Technology by implementing a hardware circuit with help of printed circuit board lab along with following experiments.

1. Fabrication of hardware circuit in PCB Lab:
    (a) Artwork & printing of a hardware circuit PCB.
    (b) Etching & drilling of PCB.
2. Testing of fabricated PCB of Proposed hardware circuit.

Note:-In addition, Institutes may include more experiments based on the expertise

SEMESTER -7

Subject: Biomedical Engineering	**Code: EL-401T**	**Credits: 4**
Branches: EL	**SEM: VII Semester**	**L T P: 310**

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

CO1: Understand fundamentals of Biomedical Engineering.
CO2: Understand basic nervous, respiratory system and Origen of biopotentials.
CO3: Understand the fundamentals of bioelectric signal and electrodes, blood gas analyzers and flow meter.
CO4: Understand the fundamentals of heart parameters, artificial pacemaker and defibrillator
CO5: Acquires basic knowledge in life therapeutic devices.

Unit 1:- Problems encountered in measuring a living system: Physiological Transducer: Pressure transducer, Transducers for body temperature measurement, pulsar sensors, respiration sensors, Blood pressure measurement of human body.

Unit 2:- Electrocardiograph (E.C.G): Block diagram of E.C.G., E.C.G. leads, Effects of Artifacts on E.C.G., Recording of E.C.G. signal, Microprocessor based E.C.G. machines, Multichannel E.C.G., Electrodes for E.C.G., Electromygraph (E.M.G,): Block Diagram of E.M.G., Electrode for E.M.G., Electroencephalograph (E.E.G.): Block diagram of E.E.G., Electrode for E.E.G., Vector Cardiograph (VCG), Apex Cardiograph, Ballisto- Cardiograph, Phonocardiograph (PCG).

Unit 3:- Blood flow measurement; Electromagnetic blood flow meter, Ultrasonic blood flow meter, NMR blood flow meter, Laser Doppler blood flow meter, Blood gas Analyzers: Blood pH measurement, electrodes for blood pH measurement, measurement for blood PCO2, blood PO2 measurement.

Unit 4:- Measurement of Heart rate: Average heart rate measurement, instantaneous heart rate meter. Pacemakers: Classification of pacemakers, Classification codes of pacemakers, Leads and Electrodes, Defibrillators: D.C. defibrillator circuit, Defibrillator electrodes.

Unit 5:- Modern imaging systems: X-ray m/c, CT scanner, Biological effect of X-ray, MRI systems, Basic NMR concept, Ultrasound imagining system, Biological effect of Ultrasound systems.

REFERENCES BOOKS

1. Biomedical Instrumentation, By R.S. Khandpur, Tata M-Graw Hill Publishing Company Limited, New Delhi.
2. Biomedical Instrumentation & Measurement by Leslie Cromwell, Fread J. Weibell, Prentice-Hall of India Pvt. Ltd.

Subject: Metrology and Calibration **Code: EL-403T** **Credits: 4**
Branches: EL **SEM: VII Semester** **L T P: 310**

Course outcomes: At the end of the course, the student will have the ability to:
CO1: understand the history and basics of measurement.
CO2: understand the term calibration and its associated terms.
CO3: understand the calibration procedure of different instruments.
CO4: understand the concept of NABL and ISO certification.
CO5: understand the estimation of measurement uncertainty using statistical methods.

Unit-1 The Metrology: History of measurement, Definition of measurement, Categories of metrology, Treaty of the meter, SI Units-Base units and derived units. Measurement areas, Fundamental of measurements- Measurements and measurand, Measuring and test equipment (M&TE), Measurement standards. Metrology Organizations-Treaty organization, General conference on weights and measures (CGPM), International Committee for Weight and Measures (CIPM).National Metrology Hierarchy in India. Metrology: an essential component of Calibration.

Unit-2 The Calibration and ISO Standards: Introduction to Calibration, general terms related to calibration-Accuracy, True value, Nominal value, Error, Uncertainty, Various types of accuracy statements, uncertainty in counts in digital meters, precision, indication of precision-conformity & no. of significant figure, Repeatability, reproducibility Calibration standards, Traceability, Traceability chart. Standard labs. conditions, Example of calibration chain, Calibration interval, calibration certificate. Introduction to ISO-9000 standards, Need of calibration in ISO standards. Requirement of the standard-Management requirement& document control. Test and calibration Laboratory Accreditation, NABL, fields of accreditations.

Unit-3 The Calibration Procedures: The General Calibration Procedure, Calibration of temperature sensors-Thermocouple, RTD and thermistor, Calibration of Pressure Gauges, Calibration of Dimensional Gauges-vernier calliper's and screw gauges, Calibration of Flow meter-analog flow-meter and calibration of Electrical parameters-voltage, current and resistance.

Unit-4 Basic Statistical Concepts: Review of some statistical concept- central tendency of data (Mean, Median, Mode), Best estimate of true value of data, Measures of dispersion, Standard deviation, Introduction and Properties of Gaussian Distribution, Area under the normal distribution curve, Mean value and standard deviation of continuous distribution of Gaussian type, Standardised normal distribution, Confidence level, Central limit theorem, Significance test.

Unit-5 Estimation of Uncertainty in Measurements: Background of Evolution of uncertainty of measurement- International perspectives on measurement uncertainty, Recommendation INC-1(1980).The Guide to the expression of uncertainty in measurement. Evaluation of Uncertainty- Type A component & type-B component. Uncertainty obtained from an assumed distribution-normal distribution, rectangular distribution & Triangular distribution. NABL guidelines for measurement of uncertainty.Examples of uncertainty calculations.

Reference Books:

1. Calibration Principles, Subburaj Ramaswamy, Vijay Nicole Imprints Pvt. Limited, Chennai, 2009.
2. Metrology and Calibration for Industrial Quality Control, Sanjeev Tyagi, Employment News, 13-19 July 2002.
3. Instrumentation, Measurement and Analysis by BC Nakra and KK Chowdhary, 4/e, Tata Mc-Graw Hill Publishing Company Limited, 2017.
4. Calibration: Philosophy in Practices, 2/e, Fluke corporation USA, 1994.
5. A course in Electrical and Electronic Measurements and Instrumentation, AK Sawhney, Dhanpat Rai and Co.

Subject: Industrial Training	**Code: EL-407**	**Credits: 2**
Branches: EL	**Semester: VII**	**L T P: 0 0 3**

Course Object

Engineering graduate program in India involve summer training as a fundamental piece of their education programs with a target to improve the information of the students. Students apply their experimental and theoretical knowledge in the field of industry

Course Outcomes: At end of the course, students will have

CO1: Ability to acquire and apply fundamental principles of science and engineering.

CO2 Ability to conduct research in the chosen field of engineering

CO3: Ability to identify, formulate and model problems and find engineering solution

CO4: Ability to conduct research in chosen field of engineering.

CO5: Ability to be a multi-skilled engineer with good technical knowledge , management, leadership, and entrepreneurship skills.

During the course of study from 3rd to 7th semester each student is expected to undertake a minimum of four industrial visits or undertake a minimum of two weeks of industry/field training. The students are expected to submit a report, which shall be evaluated by an internal assessment committee at the end of seventh semester for 100 marks or as per institute ordinances.

Subject: Seminar	**Code: EL-409**	**Credits: 2**
Branches: EL	**Semester: VII**	**L T P: 0 0 3**

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

CO1: Development of presentation Skill

CO2: Enhancement of discussion Skills

CO3: Ability of listening Skill

CO4: Creation of argumentative Skills and Critical thinking

CO5: Questioning & Answering

CO6 : Asking and exploring Interdisciplinary Inquiry

Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for a total of 100 marks or as per institute ordinances.

Subject: Biomedical Engineering Lab	**Code: EI-401P**	**Credits: 2**
Branches: EL	**SEM: VII Semester**	**L T P: 003**

Course outcome; At the end course student s are able to:

CO1: understand about ECG

CO2: Understand about EMG

CO3: Understand about EEG

CO4: Understand about blood pressure

CO5: understand about PCG

List of Experiments

1. Study of Electrocardiograph (ECG)
2. Study of Electroencephalogram (EEG)
3. Study of Electromyogram (EMG)
4. Study of blood pressure
5. Study of pulse sensor
6. Study of Phonocardiograph (PCG)

Note:-In addition, Institutes may include more experiments based on the expertise

Subject: Simulation Engineering Lab.	**Code: EL-405P**	**Credits 2**
Branches: EL	**SEM: VII**	**L T P: 002**

List of Experiments

1. Understand the main features and importance of the MATLAB/ SCI LAB mathematical programming environment.
2. Apply working knowledge of MATLAB/ SCI LAB package to simulate and solve Electrical, Electronics circuits and Applications.
3. Solve, Simulate and Analyse various DC circuits.
4. Solve, Simulate and Analyse various AC circuits.
5. Solve, Simulate and Analyse various Analog and Digital Electronics circuits.
6. Solve, Simulate and Analyse simple Transformer and DC Generator circuits.
7. Solve, Simulate and Analyse the Electromagnetics Problems,

Syllabus of Pool Elective Subjects

Subject: Semiconductor Fabrication Technology Code: EI-307T Credits: 4
Branch: EL (Pool elective) Sem: V L T P:310

Unit 1
Introduction: History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS. Electronic Materials: Crystal Structures, Defects in Crystals, Si, Poly Si, Si Crystal Growth. Clean room and Wafer Cleaning: Definition, Need of Clean Room, RCA cleaning of Si.
Oxidation: Dry and Wet Oxidation, Kinetics of Oxidation, Oxidation Rate Constants, Dopant Redistribution, Oxide Charges, Device Isolation, LOCOS, Oxidation System

Unit 2
Lithography: Overview of Lithography, Radiation Sources, Masks, Photoresist, Components of Photoresist Optical Aligners, Resolution, Depth of Focus, Advanced Lithography: E-beam Lithography, X-ray Lithography, Ion Beam Lithography.

Unit 3
Diffusion: Pre-Deposition and Drive-in Diffusion Modeling, Dose, 2-Step Diffusions, Successive Diffusion, Lateral Diffusion, Series Resistance, Junction Depth, Irvin's Curves, Diffusion System. Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Applications in ICs, Ion Implantation System, Mask, Energy Loss Mechanisms, Depth Profile, Range & Straggle, Lateral Straggle, Dose, Junction Depth, Ion Implantation Damage, Post Implantation Annealing, Ion Channeling, Multi Energy Implantation

Unit 4
Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Resistive Evaporation, Electron beam evaporation, Laser ablation, Sputtering Chemical Vapor Deposition: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, Boundaries and Flow, Different kinds of CVD techniques: APCVD, LPCVD, Metalorganic CVD (MOCVD), Plasma Enhanced CVD etc.

Unit 5
Etching: Anisotropy, Selectivity, Wet Etching, Plasma Etching, Reactive Ion Etching.
Overview of Interconnects, Contacts, Metal gate/Poly Gate, Metallization, Problems in Aluminum Metal contacts, Al spike, Electromigration, Metal Silicides, Multi-Level Metallization, Planarization, Inter Metal Dielectric

Text/Reference Books:
1. Silicon VLSI Technology, Plummer, Deal and Griffin ,1st Edition, Pearson Education,2009
2. Fundamental of Semiconductor Fabrication, Sze and May,2nd Edition, Wiley India, 2009
3. Silicon Process Technology, S K Gandhi,2nd Edition, Wiley India,2009

Subject: PCB Design & Technology **Code: EL-309T** **Credits: 04**

Semester: V (Pool Elective) **L T P: 3 1 0**

Course Outcomes: At the end of the course, the student will have the ability to:

CO1: Understand the types of board and layout general rules, parameters and designing approaches.
CO2: Understand the PCB's Design Rules for analog, Digital and High Frequency.
CO3: Understand the the Computer Aided Design of PCB's.
CO4: Understand the Fabrication Technology of Printed Circuit Board
CO5: Understand the Solders & soldering techniques.

Unit- 1: Introduction of Printed Circuit Boards

Types of PCB: Single side and double side, General considerations Layout scale, Grid system, Board types, Standards.

Layout approaches: Materials & Aids: simple approach with sketching of components, Layout sketching with Puppets, Procedures, etc.

Layout General Rules and parameters: Resistance in general, Resistance & temp, Capacitance: capacitance between conductors on opposite sides of the PCB, Inductance of PCB conductors.

Unit- 2: Design of Printed Circuit Board

Design Rules for analog circuits PCB: Placing of heat producing and heat sensitive components: Signal conductors high freq. amplifiers/oscillators, multistage amplifiers especially with high power output stage, High gain DC amplifiers (Thermal effects).

Design Rules for Digital Circuit PCB's: Main problem: Reflection, cross talk, ground and supply line noise, Electromagnetic interference from pulse type E.M. Field.

Design Rules for PCB's in High Frequency and Fast Pulse type Applications: Matching of conductors, effect of mismatch in the different cases: Effect of Mismatch in the Fast-Pulse case, in High freq. case.

Unit-3 Computer Aided Design of PCB's: Input data, component Placement, conductor Routing, Checking, Scope, etc.

Unit-4: Fabrication Technology of Printed Circuit Board

Film Master Production: Introduction, Emulsion Parameter, Film Emulsion, Increasing and Decreasing Line Width.

Photo printing: Basic properties for double-sides PCB's (Print-and-each process, Pannel plating process, Pattern plating process, Tenting process) Photoresist, in General (desirable feature of Photoresist), Wet-film Resist, Dry film resist,

Screen printing: Scope of screen-printing, Screen fibers, Patterns transfer onto the screen, (Direct method, Indirect method)

Plating: Introduction, Immersion plating, Tin immersion plating, Electro less plating, Electro plating.

Etching: Introduction, Under etching, Overhang, Etchant system, (Ferric chloride, Cupric chloride and chromic Acid)

Fabrication process of P.C.B.'s: Single side, double side PTH and multilayer PCB's Soldering

Unit-5: Solders & soldering techniques: Iron soldering, Mass soldering, Flux removal After soldering, PCB cleaning after soldering.

Reference:

PCB design and technology by Walter C Boschart Tata McGraw-Hill publishing company Ltd., New Delhi.

Subject: Mixed Signal Design	**Code: EI-311T**	**Credits: 04**
Branch: EL (Pool Elective)	**Semester: V**	**L T P: 3 1 0**

Unit 1

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.

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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.

Subject: Artificial Intelligence & Machine Learning **Code: EL-310T** **Credits: 04**
Branch: EL(Pool Elective) **Semester: VI** **L T P: 3 1 0**

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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.

Unit 6

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: DataMining, 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: OxfordUniversity Press,
5. Mitchell Tom, “Machine learning”, New York, NY: McGraw-Hill,

Subject: Information Theory and Coding	**Code: EI-312T**	**Credits: 4**
Branches: EL(Pool Elective)	**Semester: V**	**L T P: 3 1 0**

Unit 1

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

Unit 2

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

Unit 3

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.

Unit 4

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.

Unit 5

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

Subject: Computational Electromagnetics **Code: EL-314T** **Credits: 4**
Branches: EL Pool Elective **SEM: VI** **L T P: 3:1:0**

Course Objectives

• To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields

• To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as fiber optics and electronic electromagnetic structures

Course Outcome

CO1: To understand the concept of electric and magnetic field in terms of mathematical descriptions.
CO2: To understand the phenomena of electromagnetic wave and its various parameters.
CO3: To apply the mathematical concepts for deriving the wave parameters and applications.
CO4: To apply and understand the electromagnetic concepts with numerical formulation.

Unit 1

Overview of electromagnetic systems, Elements of vector calculus, scalar field,line and surface integrals, divergence and curl of vector fields, conservative field, stokes theorem, Laplacian, Electric field potential, Gauss's Law, potential – electric field and potential, potential energy, coefficients of potential and capacitance, Poisson and Laplace equations, solutions of Laplace equations, Dielectrics.

Unit 2

Magnetostatics, Equation of continuity, energy density, pointing theorem, Force between current loop, magnetic vector potential, boundary conditions, Time varying field, Faraday's law and induction.

Unit 3

Maxwell's equations and conservation of laws – angular momentum conservation – electromagnetic waves- - propagation of electromagnetic waves in different mediums- TE, TM and hybrid modes – introduction to waveguide structures.

Unit 4

Historical development of computational methods, Introduction to numerical methods, boundary conditions, error computation, method of curvilinear squares, method of moments, finite element method, Monte Carlo method.

Unit 5

FDTD simulations – selected problems in electromagnetics using python.

Text/Reference Books:

1. Matthew N.O. Sadiku& S.V. Kulkarni, "Principles of Electromagnetics", Oxford University Press, Sixth Edition 2015,
2. Matthew N.O. Sadiku, "Numerical Techniques in Electromagnetics with MATLAB", CRC Press, 2009,

Subject: Nano Electronics **Code: EL -407T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1

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

Unit 2

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

Unit 3

Resonant Tunneling Diode, Single electron transistors, Carbon nano tube electronics, Band structure and transport, devices, applications,

Unit 4

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 andNovel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nano systems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge UniversityPress,1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Subject: Microwave Integrated Circuits **Code: EL -409T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1

Introduction to Monolithic Microwave Integrated Circuits (MMICs) technology, different types of MMIC, Advantages, disadvantages and application of MMICs, MMIC fabrication techniques, Thick and Thin film technologies and materials, Encapsulation and mounting of active devices, Introduction to MM-Wave Integrated Circuits, GaAs Fabrication Technology and various processes, Materials used for MM-wave Integrated Guides.

Unit 2

Passive Circuit elements: Transmission lines for Microwave Integrated Circuits, Discontinuities, Lumped elements Passive Components: Introduction, Power transfer in parallel-coupled guides, Parallel Guide Directional Couplers, Other Directional Couplers, Ring Resonator Filters.

Unit 3

Active Semiconductor circuit elements: Schottky-barrier diodes, Varactor diodes, p-i-n diodes, Bipolar Transistors, MESFETs, HEMTs Active Components: Introduction, Image Guide Detector Circuits, Oscillators, Electronic Phase Shifters, Balanced Mixers, Amplifiers, High Frequency Devices, Low Noise MM-wave Amplifiers, Monolithic Mixers.

Unit 4

System Application:
MICs in Phased Array Radars, MICs in Satellite Television Systems, Microwave Radio Systems, Monolithic MM-wave Transceiver.

Textbooks:

1. MMIC Design by I. D. Robertson, The Institution of Electrical Engineers, U.K., 1995
2. Microwave Integrated circuit by K. C. Gupta, A. Singh, John Wiley & Sons, 1974
3. Millimeter wave Integrated Circuit by E. Carey and S. Lidholm, Springer, 2005
4. Millimeter Wave and Optical Dielectric Integrated Guides and Circuits by S. K. Koul, John Wiley & Sons, 1997.
5. Microwave Integrated Circuits by I. Kneppo, J. Fabian, P. Bezousek, P. Hrnicko and M. Pavel, Springer.
6. Stripline-like Transmission lines for Microwave Integrated circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd., New Delhi.

Subject: Introduction of MEMS **Code: EL -411T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1

Introduction and Historical Background , Scaling Effects. Micro/Nano Sensors, Actuators andSystems overview: Case studies. Review of Basic MEMS fabrication modules: Oxidation, Deposition Techniques, Lithography (LIGA), Etching.

Unit 2

Introduction to MEMS, general concepts on miniaturization and Radio frequency MEMS, Need for RF MEMS components in communications, space and defence applications Micro fabrications for MEMS Electromechanical transducers, Micro sensing for MEMS, Materials for MEMS and fabrication techniques, Thin films for MEMS and their deposition Techniques, Polymer MEMS, Silicon based MEMS, MEMS packaging

Unit 3

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.

Unit 4

RF MEMS Switches and Micro Relays: Basic design guidelines Switch parameters, Switches for RF and microwave Applications, Actuation Mechanism for MEMS Switches, Dynamics of the switch operation, MEMS switch design and modelling Micro machined MEMS Inductors, modelling and design issues of planar inductors, MEMS Capacitors.

Text/Reference Book:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
2. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering (Vol. 8). CRC press, (2005).
3. .RF MEMS and Their Applications by Vijay K.Varadan ,K.J.Vinoy,K.A.Jose Wiley India Ltd, 2011
4. RF MEMS Theory, Design and Technology by Gaberiel M.Rebiz, John Wiley & Sons, 2003.
5. Fundamentals of Microfabrication by Marc Madou, CRC Press, 1997.
6. Introduction to Microelectromechanical (MEM) Microwave Systems, H.J. De Los Santos, Artech house, 1999.

Subject: Optical fiber communication **Code: EL -413T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1

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

Unit 2

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.

Unit 3

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

Unit 4

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

Unit 5

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

Subject: Wireless Communication **Code: EL -415T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1

Introduction to wireless communications, Large scale path loss, Free space propagation model, Two ray mode, Practical link budget design, Outdoor and indoor propagation models. Small scale multi path propagation, Impulse response model of a multi path channel, Parameters of mobile multi path channels, Types of small scale Fading.

Unit 2

Rayleigh and Rician distributions, Statistical models for multipath fading channels, Theory of multipath shaping factors , Equalization, Linear, Decision feedback, Adaptive equalizers, Training and tracking. Diversity, Receiver diversity, Transmitter diversity.

Unit 3

Capacity of wireless channels, Capacity in AWGN, Flat fading channels, Frequency selective channels – Time invariant and variant channels, Performance of digital modulations over wireless channels – AWGN and Fading channels.

Unit 4

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.

Unit 5

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 book(s)

Andrea Goldmith, “Wireless Communication”, Cambridge University Press, 2005.

T.S. Rappaport, “Wireless Communication, Principles and Practice”, Pearson Education, Second Edition, 2002.

Subject: Wireless Sensor Network **Code: EL -417T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1

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.

Unit 2

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

Unit 3

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,

Unit 4

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,

Unit 5

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

Subject: Digital System Design **Code: EL -419T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

UNIT-1: Digital Design Fundamentals & Design of Combinational Circuits: Hardware Aspects Related to ASSERTED and NOT-ASSERTED conditions, The Karnaugh Map, Five and Six Variable Maps, Prime and Essential Implicants, Variable-Entered Mapping, VEM Plotting Theory, VEM Reading theory, Tabulation Method.

UNIT-2: Sequential Machine Fundamentals The Need for Sequential Circuits, Basic Architectural Distinctions between Combinational and Sequential Circuits, Concept of Memory, The Binary Cell, Fundamental Differences between Sequential Machines, The Flip-Flop, Flip-Flop Conversion from one type to another.

UNIT-3: Traditional Approaches to Sequential Analysis and Design Introduction, Analysis of Synchronous Sequential Circuits, Approaches to the Design of Synchronous Sequential Finite State Machines, Design Steps for Traditional Synchronous Sequential Circuits, State Reduction, Counters, Shift Register, Shift Register Sequences.

UNIT-4: Asynchronous Finite State Machines Why Asynchronous Circuits, Scope, Asynchronous Analysis, The Design of Asynchronous Machines.

UNIT-5: Introduction to VHDL Introduction to Hardware Descriptive Languages, Types of Modeling and Fundamental to VHDL Programming

Text books:

1. An Engineering Approach to Digital Design: William I. Fletcher (PHI)
2. Digital Design: Morris Mano (PHI

Subject: Digital Audio Processing **Code: EL-421T** **Credits: 4**
Sem.: VII (EL Pool Elective) **L T P: 3 1 0**

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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,1stedition, 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

Subject: Millimeter wave Device & circuits **Code: EL -423T** **Credits: 4**

Branch: EL Pool Elective **Sem: VII** **L T P: 3:1:0**

Unit 1:

Material Properties of Semiconductors:

Frequency range for semiconductor materials, Crystalline structure of Si, Strain of SiGe films grown on Si, Crystalline structure of GaAs, wafer orientation for semi-insulating GaAs, Orientation-dependent etching profiles of GaAs, Energy bandgaps of GaAs, Si, and Ge as a function of temperature, Electron velocity for Si, InP and GaAs, Relative dielectric constant of GaAs, Thermal conductivity of various materials, II-V heterostructures used for Microwave and RF Applications, Energy bandgap and associated lattice constants for II-V heterostructures, Double pulsed doped pseudomorphic HEMT layer structure, InP, SiC, GaN, Comparison of conventional and wide bandgap materials.

Unit 2 :

Microwave Transistors and Tunnel Diodes:

Microwave Bipolar Transistors: Physical Structures, Bipolar Transistor Configurations, Principles of Operation, Amplification Phenomena, Power-Frequency Limitations; Heterojunction Bipolar Transistors (HBTs): Physical Structures, Operational Mechanism, Electronic Applications; Microwave Tunnel Diodes: Principles of Operation, Microwave Characteristics.

Unit 3

Transferred Electron Devices (TEDs):

Gunn-Effect Diodes-GaAs Diode: Background, Gunn Effect; Ridley-Watkins--Hilsum (RWH) Theory: Differential Negative Resistance, Two-Valley Model Theory, High-Field Domain; Modes of Operation: Gunn Oscillation Modes, Limited-Space-Charge Accumulation (LSA) Mode, Stable Amplification Mode; LSA Diodes, InP Diodes, CdTe Diodes; Microwave Generation and Amplification**.**

Unit 4

Avalanche Transit-Time Devices:

Read Diode: Physical Description, Avalanche Multiplication, Carrier Current l0(t) and External Current Ie(t), Output Power and Quality Factor Q; IMPATT Diodes: Physical Structures, Negative Resistance, Power Output and Efficiency; TRAPATT Diodes: Physical Structures, Principles of Operation, Power Output and Efficiency; BARITT Diodes: Physical Description, Principles of Operation, Microwave Performance; Parametric Devices: Physical Structures, Applications.

Textbooks/ Reference books:

1. Mike Golio, The RF and Microwave Handbook, 2e, CRC Press, 2008.
2. Samuel Y. Liao, Microwave Devices and Circuits, 3e, Prentice-Hall of India, 2003.
3. S. M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, 3e, Wiley-Interscience, 2006.
4. Stephen A. Campbell, The Science and Engineering of Microelectronic Fabrication, 2/e, Oxford University Press, 2001.
5. I. A. Glover, S. R. Pennock and P. R. Shepherd, Microwave Devices, Circuits and Subsystems for Communications Engineering, John Wiley & Sons, 2005.

Syllabus of Open Elective Subjects

Subject: Engineering Economics (Open Elective) **Code: HU-402T**
Credit-4 **Sem: VIII** **L T P (3 1 0)**

UNIT I: Concepts of Engineering Economics.

- Nature, scope and importance of engineering economics.
- National Income – meaning and concept. Definition of national income, Gross National Product (GNP) and Net National Product (NNP).

UNIT II: Theory of Employment.

- Classical theory of employment – Say‟s Law.
- Keynesian theory of employment – Effective demand, Aggregate demand, Aggregate supply, Underemployment equilibrium.

UNIT III: Consumption Function.

- Keynes‟ law of consumption
- Marginal Propensity to Consume (MPC) Marginal Propensity to Save (MPS)
- **UNIT IV: Monetary Economics.**
- Functions of money
- Gresham‟s Law of Money
- Quantity Theory of Money (QTM) – Fisher‟s Version of QTM.
- Cash Balance Approach – Cambridge Equations. Comparison of Fisher equation and Cambridge equation ; Superiority of Cambridge over Fisher.

  Inflation – Definition of inflation, Demand pull inflation, Cost push inflation, Measures to control inflation.

  Deflation – Definition of deflation, Impact of deflation on different sections of society, Measures to control deflation.

UNIT V: Economic Development.

- Definition of Economic Development , obstacles to economic development.
- Definition of Economic Growth , determinants of economic growth, difference between economic development and economic growth.
- Human Development Index (HDI). Gender Inequality Index (GII).
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Reading list

Edward Shapiro, Macroeconomics, Galgotia Publication Ltd. , New Delhi.
R Dornbusch, S Fisher and R Startz, Macroeconomics, McGraw Hill, New York. D M Mithani, Macroeconomics, Himalaya Publishing House, New Delhi.

Subject: Material Imperfection and Their Application **Code: PH-429T**

Semester: VIII (Open Elective) **Credit-4** **L T P: 3 1 0**

Structure of Crystalline Solids: Fundamental concepts, unit cell, crystallographic directions and planes, Crystal systems, Metallic crystal structures.

Imperfections in Solids: Introduction, Point defects: Vacancies and self-interstitials colour centres, in purities is solids, Linear defects dislocations, Interfacial defects, Bulk or volume defects.

Diffusion in Solid: Diffusion, diffusion Mechanisms: vacancy diffusion, interstitial diffusion, steady state diffusion: Fick‟s first law, non-steady state diffusion: Fick‟s second law, Factors that influence diffusion, Applications.

Amorphous Materials: Definition, types, structure, methods of preparation of amorphous materials, Applications: optical fibers, amorphous semi-conductor, optical memories, solar cells.

Plastic deformation & Strengthening Mechanisms: Plastic deformation, the tensile stress-strain curve, modes of plastic deformation-slip and twinning, the shear strength of perfect and real crystals, the stress to move a dislocation, mechanisms of strengthening in metals by grain size reduction, solid solution strengthening, strain hardening.

Lasers: Principle, population inversion, Einstein‟s and B coefficients, types: Ruby laser, he-Ne laser, semi conductor lasers.

Books:
- Non Crystalline materials: by Davis & Mott
- Amorphous Solids: by S.R. Elliot
- Solid State Physics: by M.A. Wahab

Syllabus of Open Elective Subjects

Subject: Operations Research **Code: MA-491T** **Credits: 4**
Branches: Open Elective **Semester: VII** **L T P:310**

UNIT 1: Introduction: Definitions of O.R. and it's scope, modeling in O.R. General methods for solving O.R. models. The Monte-Carlo technique, main characteristics of O.R., main phases of O.R. Linear programming problems. Graphical method for solving L.P.P., Two phase Method, Big-M Method, problems of tie.

UNIT 2: Assignment Model: Mathematical formulation of assignment model, Reduction theorem, problems of maximization & minimization. Hungarian process, travelling salesman problems.

UNIT 3: Transportation Model : Mathematical formulation of transportation problem. Definition of FS, BFS, Optimum solution. Algorithms of N-W rule, Least-cost & VAM and their problems.

UNIT 4: Sequencing: Introduction, principle assumptions processing of jobs through two, three & m-machine's.

UNIT 5: Game Theory: Characteristics of Games. Basic definitions, minimax criterion and optimal strategy. Equivalence of rectangular Games, Dominance process, Arithmetic method for solving zero-sum-two persons Games. Graphical and simplex methods for solving the games.

UNIT 6: Replacement: Failure mechanism of items, replacement of items that deteoriate, Replacement of item that fail completely.

UNIT 7: Inventory : Elementary Inventory Models, Inventory models with price breaks.

Reference Books:

1. G. Hadley: Linear programming, Narosa Publishing house, 1995.
2. Mokhtar, S. Bazara, John, J. Jarn‟s and Hanif, D. Sherali: Linear Programming and network flows, John Wiley & Sons, New York 1990.
3. H.A.Taha: Operations Research-An Introduction, Macmillan Publishing Co. Inc. New York.
4. Kantiswarup, P.K. Gupta and Man Mohan: Operations Research, Sultan Chand & Sons, New York.

Subject: Polymeric Materials and Their Applications **Code: CY-401T**
Semester: Open Elective **Credit-4** **L T P: 3 1 0**

1. **Basic Polymer Chemistry:** Definition, Classification, Types of polymerization.
2. **Resins and Plastics:** Thermoplastic and thermosetting resins, constituents of plastics, fabrication of plastic materials, Important resins, Cellulose derivatives, Polyethylene, Teflon, Polystyrene, Polyvinylacetate, PVC, Nylons, Phenolic resins Phenol-Formaldehyde, Urea and Malamine-Urea and melamine-Formaldehyde resins, Epoxy resins, Polyester, Silicones, Lon exchange resins.
3. **Rubbers/Elastomers:** Natural rubber, compounding of rubber, Properties, uses, reclaimed rubber, Synthetic rubber, Buna-S, Nitrile rubbers, Fibre reinforced plastics (FRP).
4. **Biopolymers:** Importance and applications of few important biopolymers eg. Proteins, carbohydrates etc.

PH -419 T	**Futuristic Materials**	**Credits: 4**
Branches: Open Elective	**Semester: VII**	**L T P:310**

Semiconductors:

Introduction of semiconductors, intrinsic and extrinsic, II-VI and IIIV semiconductors and its alloys, Advantages and necessity of the tailoring of semiconductor, Semiconductors and it alloys used of LED and other devices, Utility of semiconducting alloys like GaAIAs, GaAIN, GaAIP etc.

Superconductors:

Fundamental Phenomenon associated with superconductors. Type I& II superconductors, Meissner Ochenfeld effects, Josephon effects, fundamental of BCS theory. Novel High Temperature Superconductors. Hole superconductors, TIBaCaCuO single and bilayer. Electron superconductors NdCuO etc. Doping effects in superconductors, Organic superconductors, fullerenesl. Application of the superconductors in science, medical and commercial sectors.

Material for Magnetic media:

Material useful for magnetic recording head, magnetic disk, magnetic tape media, Magneto optic recording materials. Holography, data storage materials.

Holography:

Fundamentals of holography, Difference between conventional photography and holography. Techniques to make a hologram. Advantages of holography over other techniques.

Introduction of following with applications:

Fibre optics, Lasers, Ceramics, Dielectric Characterization of Materials.

Books: 1) Superconductivity Today: T.V. Ramakrishna & C.N.R. Rao Wiley astern Pvt. Ltd, New Delhi, 1992

2) Solid State Physics: Ashcrost/Mervin

Code: HU-449 T **Subject: Principle of Management** **Credits: 4**
Semester: VII (Open Elective) **L T P: 3 1 0**

UNIT-1: Management as a discipline: Definition, nature, scope, functions, managerial Skills, Management. Thought-Historical Prospective, Social Responsibility, of Business.

UNIT-2: Planning: Concept and purpose, planning process, Management, By Objectives(MBO), Decision making.

UNIT-3: Organization: Concept and purpose of organisation, types of organisation, bases of Departmentation, concept of Authority and Responsibility, Span of Management, Line and Staff Authority, Functional Authority, Delegation of Authority, Centralization and Decentralization of Authority, Coordination Staffing.

UNIT-4: Directing: Leadership Concept, Ingredients, Traits, Styles, Roles Communication Concept. Types, Process Barriers, Making Communication effective, Importance.

UNIT-5: Controlling: Concept, Provides, Requirements, for adequate control, controlling and earning, Budgeting control Importance, Management Audit, Management in future.

Subject: Quantitative Methods in Economics **Code: HU-409T**
Semester: VII (Open Elective) **Credit-4** **L T P: 3 1 0**

UNIT:1 **Statistics:** Definition, Importance, Scope and Limitations of statistics, primary and secondary data. Classification of Meaning: objectives and types of classification. Frequency Distribution: Discrete, Grouped and continuous frequency distributions. Fundamentals of frequency distribution.

UNIT:2 **Measures of Central Tendencies:** arithmetic mean, Median, Mode, Geometric Mean and Harmonic Mean, Demerits and Uses of all methods.

UNIT:3 **Measures of Dispersion:** Mean deviation Method about Mean, Median and Mode, Merits and Demerits of Mean Deviation. Coefficient of M.D. Standard Deviation (S.D.) Method with simple short-cut and step deviation methods.Merits and Demerits of S.D. Coefficient of S.D.

UNIT:4 **Correlation:** Introduction, Types of Correlation, Karl Pearson‟s Coefficient of Correlation. Interpretation of „r‟. Probable Error, Uses of Probable Error.

UNIT:5 **Linear Regression Analysis:** Introduction, Two method of Linear Regression Analysis:- (1) Line of Regression of Y on X and (2) Line of Regression and X on Y. Why two lines of regression Coefficient of Regression. Relation between the coefficient of correlation and Regression.

UNIT:6 Index Number: Definition, Uses and Types of Index Numbers, Methods of Construction Index Numbers-(1) Simple Aggregate Method (2) Weighted Aggregate Method (3) Fisher‟s Ideal Index Numbers (4) const of living Index Numbers (5) Chain Base Index Numbers. Base Shifting.Limitations of Index Numbers.

SEMESTER -8

Subject: Major Project/Internship **Code: EL-402P*** **Credits: 24**

Branches: EL **Sem: VIII Semester** **L T P: 0 0 3**

Course outcomes: At the end of the course, the student will have the ability to:

CO1: understand the final design of project in a team spirit.

CO2: implement the literature survey in her/his project.

CO3: learn technical interaction with her/his project supervisor.

CO4: finalize and validation of her/his project.

CO5: to present her/his work to any national/international conference or Journal.

The objective of the Major Project/Internship is to enable the students to work in groups of not more than three members in each group on a project involving analytical, experimental , design or combination of these in the area of Electronics and Instrumentation Engineering. Each project shall have a guide or co- guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem.

Under the major project, student will do the project work/Internship in our university or any other identified industry/research institute/University/ of repute. The students will devote his/her 8^{th} semester for this project/internship and prepare a comprehensive project report whose evaluation will be done by the department.

In the middle of the project work/internship, student has to deliver a progress report presentation in the department. On the basis of progress report presentation and a confidential report from the concerned guide, the sessional marks will be prepared by the departmental project coordinator duly nominated by the Head of the department.

***new code w.e.f. academic session 2023-24.**

Minor Degree in "Artificial Intelligence and Machine Learning"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	AIML-01T	Introduction to AI & Machine Learning	3	0	0	3
2	AIML-01P	Introduction to AI & Machine Learning Lab	0	0	2	1
3	AIML-02T	Introduction to Data Analytics	3	1	0	4
4	AIML-03T	Deep Learning and Neural Network	3	1	0	4
5	AIML-04T	Special topics in Artificial Intelligence	3	1	0	4
6	AIML-05T	Applications of AI	3	0	0	3
7	AIML-05P	Applications of AI Lab	0	0	2	1
TOTAL			**15**	**3**	**4**	**20**

Detailed Syllabus

Course Code	:	AIML-01T
Course Title	:	Introduction to AI & Machine Learning
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	AIML

Course Objective:

- To review and strengthen important mathematical concepts required for AI & ML.
- Introduce the concept of learning patterns from data and develop a strong theoretical foundation for understanding state of the art Machine Learning algorithms.

Course Contents:

Unit 1

Defining Artificial Intelligence, Defining AI techniques, Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Mathematical foundations: Matrix Theory and Statistics for Machine Learning.

Unit 2

Idea of Machines learning from data, Classification of problem –Regression and Classification, Supervised and Unsupervised learning.

Unit 3

Linear Regression: Model representation for single variable, Single variable Cost Function, Gradient Decent for Linear Regression, Gradient Decent in practice.

Unit 4

Logistic Regression: Classification, Hypothesis Representation, Decision Boundary, Cost function, Advanced Optimization, Multi-classification (One vs All), Problem of Overfitting.

Unit 5

Discussion on clustering algorithms and use-cases cantered around clustering and classification.

Text Books/References:

1. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011.
2. Anindita Das Bhattacharjee, “Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
3. M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, Delhi.
4. Jeeva Jose, Introduction to Machine Learning, Khanna Publishing House, Delhi.
5. Yuxi (Hayden) Liu, “Python Machine Learning by Example”, Packet Publishing Limited, 2017.
6. Tom Mitchell, Machine Learning, McGraw Hill, 2017.

7. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
8. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2011.

Corresponding Online Resources:

1. Artificial Intelligence, https://swayam.gov.in/nd2_cec20_cs10/preview.

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

1. Design and implement machine learning solutions to classification, regression and clustering problems.
2. Evaluate and interpret the results of the different ML techniques.
3. Design and implement various machine learning algorithms in a range of Real-world applications.

Course Code	:	AIML-02T
Course Title	:	Introduction to Data Analytics
Number of Credits	:	4 (L: 3; T: 1; P:)
Course Category	:	AIML

Course Objective:

- Provide you with the knowledge and expertise to become a proficient datascientist
- Demonstrate an understanding of statistics and machine learning concepts thatare 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:

Unit 1
Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science.

Unit 2
Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDA-Quantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions.

Unit 3
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.

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

Unit 5
Applications of Data Science, Data Science and Ethical Issues- Discussions on privacy, security, ethics- A look back at Data Science- Next-generation data scientists.

Text Books/References:

1. Joel Grus, Data Science from Scratch, Shroff Publisher Publisher /O'Reilly Publisher Media
2. V.K. Jain, Big Data and Hadoop, Khanna Publishing House
3. V.K. Jain, Data Sciences & Analytics, Khanna Publishing House
4. Annalyn Ng, Kenneth Soo, Numsense! Data Science for the Layman, Shroff Publisher Publisher
5. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly Publisher Media.
6. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets.

v2.1, Cambridge University Press.
7. Jake VanderPlas, Python Data Science Handbook, Shroff Publisher Publisher /O'Reilly Publisher Media
8. Philipp Janert, Data Analysis with Open Source Tools, Shroff Publisher Publisher /O'Reilly Publisher Media.

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

1. Explain how data is collected, managed and stored for data science;
2. Understand the key concepts in data science, including their real-world applicationsand the toolkit used by data scientists;
3. Implement data collection and management scripts using MongoDB.

Course Code	:	AIML-03T
Course Title	:	Deep Learning and Neural Network
Number of Credits	:	4 (L: 3; T: 1; P: 0)
Course Category	:	AIML

Course Objective:

- To strengthen important Mathematical concepts required for Deep learning andneural network.
- To get a detailed insight of advanced algorithms of ML.

Course Contents:

Unit 1
Information flow in a neural network, understanding basic structure and ANN.

Unit 2
Training a Neural network, how to determine hidden layers, recurrent neural network.

Unit 3
Convolutional neural networks, image classification and CNN.

Unit 4
RNN and LSTMs. Applications of RNN in real world.

Unit 5
Creating and deploying networks using tensor flow and keras.

Text Books/References:

1. Rajiv Chopra, Deep Learning, Khanna Publishing House.
2. John Paul Mueller, Luca Massaron, Deep Learning for Dummies, John Wiley & Sons.
3. Adam Gibson, Josh Patterson, Deep Learning, A Practitioner's Approach, Shroff Publisher /O'Reilly Publisher Media.
4. Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford.
5. Russell Reed, Robert J MarksII, Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks, Bradford Book Publishers.

Corresponding Online Resources:

1. Fuzzy Logic and Neural Networks, https://swayam.gov.in/nd1_noc20_ge09/preview.

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

1. To design and implement Artificial Neural networks.
2. To decide when to use which type of NN.

Course Code	:	AIML-04T
Course Title	:	Special topics in Artificial Intelligence
Number of Credits	:	4 (L: 3; T: 1; P: 0)
Course Category	:	AIML

Course Objective: To give fundamental knowledge to the students so that they can understand what the AI is and study important topics related to the field.

Course Contents:

Unit 1
Bayesian Filtering; Recurrent Neural Networks, Deep Neural Networks, Deep Reinforcement Learning.

Unit 2
Self-Play Networks, Generative Adversarial Networks, Learning from Concept-Drifting Data Streams.

Unit 3
Audio Signal Processing Basics, mirtoolbox contains many useful audio processing library functions, VOICEBOX: Speech Processing Toolbox for MATLAB, Audio processing in Matlab.

Unit 4
Architectures for second generation knowledge based systems, Distributed AI and its applications.

Unit 5
An introduction to neurocomputing and its possible role in AI, The role of uncertainty measures and principles in AI.

Text Books/References:

1. Dr. Nilakshi Jain, Artificial Intelligence: Making a System Intelligent, John Wiley & Sons.
2. M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, Delhi.
3. Artificial Intelligence & Soft Computing for Beginners, 3rd Edition-2018, by Anindita Das, Shroff Publisher Publisher.
4. Artificial Intelligence: A Modern Approach, 3rd Edition, by Stuart Russell and Peter Norvig, Pearson Publisher.
5. New Artificial Intelligence (Advanced), Takashi Maeda and Fumio Aoki, Ohmsha Publisher.

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

1. To understand various AI techniques.
2. To decide when to use which type of AI technique.

Course Code	:	AIML-05T
Course Title	:	Applications of AI
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	AIML

Course Objective: To give deep knowledge of AI and how AI can be applied in various fields to make the life easy.

Course Contents:

Unit 1
Linguistic aspects of natural language processing, A.I. And Quantum Computing, Applications of Artificial Intelligence (AI) in business.

Unit 2
Emotion Recognition using human face and body language, AI based system to predictthe diseases early, Smart Investment analysis, AI in Sales and Customer Support.

Unit 3
Robotic Processes Automation for supply chain management.

Unit 4
AI-Optimized Hardware, Digital Twin i.e. AI Modelling, Information Technology & Security using AI.

Unit 5
Recent Topics in AI/ML: AI/ML in Smart solutions, AI/ML in Social Problems handling, Block chain and AI.

Text Books/References:

1. Sameer Dhanrajani, AI and Analytics, Accelerating Business Decisions, John Wiley & Sons.
2. Life 3.0: Being Human in the Age of Artificial Intelligence by Max Tegmark, published July 2018.
3. Homo Deus: A Brief History of Tomorrow by Yuval Noah Harari, published March 2017.
4. Artificial Intelligence in Practice: How 50 Successful Companies Used AI and Machine Learning to Solve Problems, Bernard Marr, Matt Ward, Wiley.

Course Outcomes: After completion of course, students would:

1. To correlate the AI and solutions to modern problem.
2. To decide when to use which type of AI technique.

Course Code	:	AIML-01P
Course Title	:	Introduction to AI & Machine Learning Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	AIML

Lab Work:

1. Implementation of logical rules in Python.
2. Using any data apply the concept of:
    a. Liner regression
    b. Gradient decent
    c. Logistic regression
3. To add the missing value in any data set.
4. Perform and plot under fitting and overfitting in a data set.
5. Implementation of clustering and classification algorithms.

Text Books/References:

1. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011.
2. Anindita Das Bhattacharjee, "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
3. M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, Delhi.
4. Jeeva Jose, Introduction to Machine Learning, Khanna Publishing House, Delhi.
5. Yuxi (Hayden) Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.

Course Code	:	AIML-05P
Course Title	:	Applications of AI Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	AIML

Lab Work :

1. Learn existing datasets and Treebanks
2. Implementation of searching techniques in AI.
3. Implementation of Knowledge representation schemes.
4. Natural language processing tool development.
5. Application of Machine learning algorithms.
6. Application of Classification and clustering problem.
7. Working on parallel algorithms.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Elicit, analyze and specify software requirements.

CO2: Simulate given problem scenario and analyze its performance.

CO3: Develop programming solutions for given problem scenario.

Minor Degree in “Internet of Things”

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	IoT-01T	Introduction to Internet of Things	3	1	0	4
2	IoT-02T	Introduction to Security of Cyber-Physical Systems	3	1	0	4
3	IoT-03T	Ubiquitous Sensing, Computing and Communication	3	1	0	4
4	IoT-04T	Embedded Systems for IoT	3	0	0	3
5	IoT-04P	Embedded Systems for IoT Lab	0	0	2	1
6	IoT-05T	IoT with Arduino, ESP, and Raspberry Pi	3	0	0	3
7	IoT-05P	IoT with Arduino, ESP, and Raspberry Pi LAB	0	0	2	1
TOTAL			**15**	**3**	**4**	**20**

Detailed Syllabus

Course Code	:	IoT-01T
Course Title	:	Introduction to Internet of Things
Number of Credits	:	3 (L: 3; T: 1; P: 0)
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:

Unit 1

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.

Unit 2

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.

Unit 3

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.

Unit 4

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.

Unit 5

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.

Course Code	:	IoT-02T
Course Title	:	Introduction to Security of Cyber-Physical Systems
Number of Credits	:	4 (L: 3; T: 1; P: 0)
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:

Unit 1
Overview of Security and Privacy in Information System.

Unit 2
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.

Unit 3
Internet of Things Security, Security and Privacy for IoT Case Study: Smart Home, Smart Grid Network, Modern Vehicle, Wearable Computing & BYOD, Mobile HealthCare.

Unit 4
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.

Unit 5
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 securit

Course Code	:	IoT-03T
Course Title	:	Ubiquitous Sensing, Computing and Communication
Number of Credits	:	4 (L: 3; T: 1; P: 0)
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:

Unit 1
Introduction, Overview, Challenges in IoT, Networking Basics of IoT, NFC, Wireless LAN.

Unit 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 andChallenges, Developing Context-aware Applications, System Architecture.

Unit 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.

Unit 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.

Unit 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.

Course Code	:	IoT-04T
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:

Unit 1
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.

Unit 2
Design of Embedded Systems: Common Sensors, Actuators, Embedded Processors, Memory Architectures, Software architecture.

Unit 3
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).

Unit 4
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.

Unit 5
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.

Course Code	:	IoT-05T
Course Title	:	IoT with Arduino, ESP, and Raspberry Pi
Number of Credits	:	3 (L: 3; T: 0; P: 0)
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 IoTarchitectures.
- To develop skills on data collection and logging in the cloud.

Course Contents:

Unit 1

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).

Unit 2

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.

Unit 3

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).

Unit 4

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.

Unit 5

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."

Course Code	:	IoT-04P
Course Title	:	Embedded Systems for IoT Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	IoT

Course Code	:	IoT-05P
Course Title	:	IoT with Arduino, ESP, and Raspberry Pi Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	IoT

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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Minor Degree in “Robotics”

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	ROB-01T	Introduction to Robotics	3	1	0	4
2	ROB-02T	Mechanics of Robots	3	1	0	4
3	ROB-03T	Microprocessor & Embedded Systems	3	0	0	3
4	ROB-03P	Microprocessor & Embedded Systems Lab	0	0	2	1
5	ROB-04T	Control of Robotic Systems	3	0	0	3
6	ROB-04P	Control of Robotic Systems Lab	0	0	2	1
7	ROB-05T	Project in Robotics	1	0	6	4
TOTAL			**13**	**2**	**10**	**20**

Detailed Syllabus

Course Code	:	ROB-01T
Course Title	:	Introduction to Robotics
Number of Credits	:	4 (L: 3; T: 1; P: 0)
Course Category	:	ROB

Course Objective: This course aims to familiarize students with basic terminologies of the robotics sciences and essential knowledge required to get started in the field of Robotics.

Course Contents:

Unit 1

Introduction to robotics : Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

Unit 2

Grippers and Sensors for Robotics: Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basicgripper system.
Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot.

Unit 3

Drives and Control for Robotics: Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control

Unit 4

Programming and Languages for Robotics: Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS.

Unit 5

Related Topics in Robotics: Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.

Text Books/References:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
4. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co

Ltd,New Delhi (2003)
5. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
6. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997)
7. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt Ltd (2012)
8. R. D. Klafter, Thomas A. Chmielewski, and Mechael Negin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009)

Alternative SWAYAM/NPTEL Course:

NPTEL Course Name	Instructor	Host Institute
Introduction to robotics	Dr. Krishna Vasudevan, Dr. Balaraman Ravindran, Dr. T Asokan	IIT Madras
Sensors and Actuators	Prof. Hardik Jeetendra Pandya	IISc Bangalore

Course Outcomes: After completion of course, students would be able:
1. To express his views as per terminologies related to Robotics technology.
2. To apply logic for selection of robotic sub systems and systems.
3. To analyse basics of principals of robot system integration.
4. To understand ways to update knowledge in the required area of robotic technology.

Course Code	:	ROB-02T
Course Title	:	Mechanics of Robots
Number of Credits	:	4 (L: 3; T: 1; P: 0)
Course Category	:	ROB

Course Objective: This course aims to inculcate thorough understanding about basic knowledge of mathematics, kinematics and dynamics required for understanding motion programming and operational / control functionality in robotics.

Course Contents:

Unit 1

Mathematical Preliminaries of Robotics: Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.

Unit 2

Robot Kinematics: Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach.

Unit 3

Velocities & Statics: Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, , Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation, Forces, Velocity/Force Duality, Virtual Work, Force ellipsoid, Jacobian, Kinematic Singularity, Kinematics redundancy, Mechanical Design of robot linkages,

Unit 4

Robot Dynamics: Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation, computational consideration.

Text Books/References:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
2. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
4. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
5. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison-Wesley (2003).

Alternative SWAYAM/NPTEL Course:

NPTEL Course Name	Instructor	Host Institute

Robotics	Prof. Dilip Kumar Pratihar	IIT Kharagpur
Robotics	Prof. P. Seshu, Prof. P.S. Gandhi, Prof. K. Kurien Issac, Prof. B. Seth, Prof. C. Amarnath	IIT Bombay

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

1. To understand terminologies related to Kinematics and Dynamics of Robotics.
2. To apply mathematics for manipulator positioning and motion planning.
3. To analyse basics of motion programming as per kinematics.
4. To estimate the force/torque required to drive a robot.

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Course Code	:	ROB-03T
Course Title	:	Microprocessor and Embedded Systems
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	ROB

Course Objective: This course aims to teach the detailed functioning of microprocessors and the role of embedded systems in a robotic system.

Course Contents:

Unit 1

Introduction to Embedded Systems and microcomputers: Introduction to Embedded Systems, Embedded System Applications, Block diagram of embeddedsystems, Trends in Embedded Industry, Basic Embedded System Models, Embedded System development cycle, Challenges for Embedded System Design, Evolution of computing systems and applications. Basic Computer architecture: Von-Neumann and Harvard Architecture. Basics on Computer organizations. Computing performance, Throughput and Latency, Basic high performance CPU architectures, Microcomputer applications to Embedded systems and Mechatronics.

Unit 2

Microprocessor: 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts. Introduction to C language, Instruction format, C language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor.

Unit 3

Microprocessor Interfacing: Introduction to interfacing, Memory Interfacing, Programmable Peripheral Interfacing, Programmable I/O, Programmable Interrupt Controller, Programmable Timers, Programmable DMA Controller, Programmable Key Board Controller, Data acquisition Interfacing: ADC, DAC, Serial and parallel data Communication interfacing. Microcontroller: Introduction to Microcontroller and its families, Criteria for Choosing Microcontroller. Microcontroller Architecture, Programming model, addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O programming using assembly and C language, Interrupt Controller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols, SPI Controllers. LCD Controller.

Unit 4

Microcontroller Interfacing: Introduction to Microcontroller Interfacing and applications: case studies: Display Devices, controllers and Drivers for DC, Servoand Stepper Motor.

Unit 5

Introduction to Advanced Embedded Processor and Software: ARM Processor, Unified Model Language (UML), Embedded OS, Real Time Operating System (RTOS), Embedded C.

Text Books/References:

1. K. V. Shibu, Introduction to Embedded Systems, McGRAW Hill Publications (2009).
2. Raj Kamal, Embedded Systems, TATA McGRAW Hill Publications (2003).
3. M. Morris Mano, Computer System Architecture, 3ed, Pearson Publication, (2007).

4. D. V. Hall, 8086 Microprocessors and Interfacings, TATA McGRAW Hill, (2005).
5. B. B. Brey, The Intel Microprocessors, Prentice Hall Publications, 8th ed, (2018).
6. M. A. Mazidi, R.D. Mckinlay and D. Casey, PIC Microcontrollers and Embedded Systems, Pearson Publications, (2008).
7. M. Predko, Programming and Customizing the PIC Microcontroller, McGRAW Hill Publications. 3ed, (2017).
8. R. Barnett, L. O'Cull and S. Cox, Embedded C Programming and Microchip PIC, Cengage Learning, (2003).

Alternative SWAYAM/NPTEL Course:

NPTEL Course Name	Instructor	Host Institute
Embedded Systems	Prof. Santanu Chaudhary	IIT Delhi

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

1. To prepare block diagrams for any robotic control-hardware design,
2. To choose appropriate flow of embedded systems for a specific application.
3. To Write code for micro controller devices.
4. To use advanced embedded processor and software.

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Course Code	:	ROB-04T
Course Title	:	Control of Robotic Systems
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	ROB

Course Objective: This course aims to develop the understanding of control systems, its designing and application.

Course Contents:

Unit 1

Basics of Control: Differential Equation, Transfer function, Frequency response, Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design, lag-lead design, Bode, polar, Nyquist plot.

Unit 2

Linear Control: Concept of states, state space model, different form, controllability, observability; pole placement by state feedback, observer design, P, PI & PID Controller, control law partitioning, modelling and control of a single joint.

Unit 3

Non-Linear Control System: Common physical non-linear system, phase plane method, system analysis by phase plane method, stability of non-linear system, stability analysis by describing function method, Liapunov's stability criterion, the control problems for manipulators.

Unit 4

Motion Control: Point to Point Control, trajectory generation, Continuous Path Control, Joint based control, Cartesian Control, Force Control, hybrid position/force control system.

Text Books/References:

1. M. Gopal, Control Systems, McGraw-Hill (2012)
2. K. Ogata, "Modern Control Engineering", Prentice Hall India (2009).
3. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
4. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison-Wesley (2003).
5. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
6. Thomas Kailath, "Linear Systems", Prentice Hall (1980).
7. Alok Sinha, "Linear Systems: Optimal and Robust Control", Taylor & Francis(2007).

Alternative SWAYAM/NPTEL Course:

NPTEL Course Name	Instructor	Host Institute
Robotics and Control : Theory and Practice	Prof. N. Sukavanam, Prof. M. Felix Orlando	IIT Roorkee

Control systems	Prof. C.S.Shankar Ram	IIT Madras

Course Outcomes: After completion of course, students would have thorough understanding of linear, non-linear control systems and Motion Control.

Course Code	:	ROB-05T
Course Title	:	Project in Robotics
Number of Credits	:	4 (L: 1; T: 0; P: 6)
Course Category	:	ROB

Course Objective:

To assimilate the theoretical knowledge gained in the lecture courses (ROB-1 to 4) forreal-life practical applications in order have effective learning and skill-development, mainly, from the point of view of the employability in industries.

Course Contents:

This course is a project type. The plan of conducting this course is given below:

1. Participants will be divided into teams of two/four members within first week of the starting of the course by the course coordinators/managers depending on the number of participants registered in the course. The benefits of such team-based projects are listed in the Course Outcomes below.

2. The teams will have a team coordinator or leader, which will be identified by the coordinators/managers of the course (may be the first name in the list of a student team).

3. The projects could be of the following types:

    a. Literature search (LS) type: Studying about an aspect of robotics, say, vision, robot kinematics, dynamic, controls, etc.

    b. Algorithm development (AD) type: Analyse, say, a robot kinematics using RoboAnalyzer or Matlab/Octave/Freemat/Scilab or similar software or write an algorithm using any programming language (Python, etc.). For example, writing forward kinematics of a robot or image processing in Vision.

    c. Design/synthesis (DS) type: Proposing a new type of system/device for performing certain task. For example, a mobile robot for Covid-19 isolation wards.

4. The teams will be asked to contact their team members within a week and decide their topic with two weeks, i.e., within first 3 weeks of the starting of the course.

5. Students MUST spend about 6 hours in a week to discuss their progress together, study together or individually, write programmes, fabricate circuits, etc.

6. During the one lecture hour the coordinators will explain how to do literature survey, how to find the sources of hardware, which software to use for a particular purpose,

how to select an electric motor, etc., present case studies, etc.

7. At the end of the course duration, each team will submit no more than 10 slides in .pdf file and/or not more than a video of one min to showcase their project hardware/software/plots, etc. generated during the project to a cloud (say, Google Drive).

8. Evaluation: It will be done in two parts
    a. Peer Evaluations (20%): Presentations in .pdf will be evaluated (online) by two other teams and grade them out of 10 marks.
    b. Expert evaluation (80%): Coordinators will take a presentation of 3 mins. plus, Q&A in a common online session to give marks out of 80.

Text Books/References:

Since it is a project type, some experience sharing books and links to similar activitiesare listed.

1. Chuhan, M., and Saha, S.K., 2010, Robotics Competition Knowledge Based Eduation in Engineering, Pothi.com
2. Baun, M., and Chaffe, J., 2018, Engineering and Building Robots for Competitions, Amazon.com

Corresponding Online Resources:

1. http://www.ddrobocon.in/
2. http://courses.csail.mit.edu/iap/6.095/

Course Outcomes:

The outcomes are envisaged as follows:

1. Each participant will know students from other colleges/states and their work ethics/culture.
2. To Practice how to work together in a team. An essential skill in an industry.
3. To apply the theoretical knowledge learnt from other courses, which is required by an industry.
4. To learn how to make presentation in a team. A soft skill needed in research and industry.
5. Peer learning from the evaluation of other teams' work. A skill which is essential when one is in a workforce.
6. To examine different hardware components and their working/control using software.

Course Code	:	ROB-03P
Course Title	:	Microprocessor and Embedded Systems
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	ROB

Microprocessor and Embedded System Laboratories: Basic C language programming implementation on Microprocessor and Microcontroller. Interfacing Displays, Key boards and sensors with Microprocessors and Microcontrollers, Data Acquisition using Microprocessor and Microcontroller, Implementation of Controlling schemes for DC, Servo, Stepper motor using C programming in microprocessors and Microcontrollers.

Course Code	:	ROB-04P
Course Title	:	Control of Robotic Systems Lab
Number of Credits	:	1 (L: 0; T: 0; P: 2)
Course Category	:	ROB

List of experiments

1- Determination of maximum and minimum position of links.

2- Verification of transformation (Position and orientation) with respect to gripper and world coordinate system

3- Estimation of accuracy, repeatability and resolution.

4- Robot programming and simulation for pick and place

5- Robot programming and simulation for colour identification

6- Robot programming and simulation for Shape identification

7- Robot programming and simulation for machining (cutting, welding)

8- Robot programming and simulation for writing practice

9- Robot programming and simulation for any industrial process (Packaging, Assembly)

10- Robot programming and simulation for multi process.

Minor Degree in "Electric Vehicles"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	EV-01T	Power Train and Motor Design	3	1	0	4
2	EV-02T	Battery Management System	3	1	0	4
3	EV-03T	EV Charging Infrastructure technology	3	0	0	3
4	EV-03P	EV Charging Infrastructure technology LAB	0	0	2	1
5	EV-04T	Embedded system for EV	3	0	0	3
6	EV-04P	Embedded system for EV Lab	0	0	2	1
7	EV-05T	Modelling of Electric Vehicles	1	0	6	4
TOTAL			**13**	**2**	**10**	**20**

Detailed Syllabus

Course Code	:	EV-01T
Course Title	:	Powertrain and Motor Design
Number of Credits	:	4 (L: 1; T: 1; P: 0)
Course Category	:	Electric Vehicles (EV)

Course Objective:

This course is designed to make a student capable of intuitively understanding all the important elements of an EV powertrain, and also be able to design a miniaturized electric vehicle powertrain using electrical/electronic components with knowledge acquired in this course.

Course Outline:

Unit 1

Basics of electric motors

In this module, the students learn to assemble their own motor from scratch, which includes winding their own coils and designing their motors. Students also learn Finite Element Method Magnetics (FEMM) modelling by simulating the motor they have built, which helps them simulate and model efficient motors.

Unit 2

Motor controller basics

In this module, the students design their own motor controller from scratch using MOSFETs, and an Arduino circuit and in turn learn the theory and operation behind the working of a motor controller.

Unit 3

Charging Technology and Implementation

This module goes into the basics of charging technology and types of charging architecture existing globally. Students learn about the charging process and the variables associated with charging an EV.

Unit 4

Communication Protocols

In this module, students learn about automotive communication, various communication protocols used in EVs. Students gain practical learning by designing and building an I2C (Inter-Integrated Circuits) communication bus to communicate between the Motorcontroller and BMS to act as an

intelligent system similar to a CAN (Controller Area Network)bus, which is widely used in the industry to communicate with various components of an automobile.

Unit 5

Looking into practical case studies

In this module, students look into a case study specifically on a Formula electric design paperand understand their design process. They also reverse engineer and simulate a BLDC motorusing Finite Element Method Magnetics (FEMM).

Unit 6
Regulations for Electric Powertrain Vehicle manufacturers

In this module, students learn about various types of regulations and standards set in the CMVR (Central Motor Vehicles Rules - 1989) for selecting and manufacturing various components of an electric vehicle. Students will also gain an understanding about retrofitment solutions and also the rules and regulations they will need to follow while designing a retrofit powertrain model.

This module also covers the basics of Carbon footprint of companies and understand how companies utilize carbon credits to reduce their carbon footprint issues and touches on international and national carbon credit incentives and policies to further help reduce greenhouse gases in the environment.

Text/Reference Books:

- This course does not require students to use physical textbooks. Instead, original course material (videos, text and images) has been prepared for students to go through and is open-sourced under Creative Commons Attribution-ShareAlike 4.0 International License © Micelio Mobility Pvt. Ltd.
- Link to course - https://www.pupilfirst.school/courses/643/curriculum
- This course material may include some third-party content with a compatible license,and external links for additional reading on the Internet. Students are also taught howto search for information on their own.

Course Outcomes:

By the end of the course, the students will be able to:

- Students will be able to visualize the working of an EV powertrain.
- Gain confidence to build and design their own motors and powertrain componentsfrom scratch.
- Gain a basic understanding of how EV power electronic systems work by building a Motor controller.
- Identify various communication protocols and technologies used in vehicle networks.
- Develop an electric vehicle powertrain prototype using locally procured hardware components.

Course Code	**:**	**EV-02T**
Course Title	**:**	**Battery management system**
Number of Credits	**:**	**4 (L: 3; T: 1; P: 0)**
Course Category	**:**	**Electric Vehicles (EV)**

Course Objective:

Students will get an opportunity to interact with course coaches'/course authors who are industry experts and practitioners in the EV domain. Students will assist in the learning process of students and while doing so, they will develop a more in-depth understanding ofEV concepts and practices.

Unit 1

Modelling energy consumption

This module teaches students about various driving cycles and energy consumption. The students learn to simulate the energy consumption and vehicle range using the WLTP energyconsumption model.

Unit 2

Understanding Batteries

In this module, students learn the basics of Lithium-ion batteries. It covers how batteries work, how to choose the appropriate batteries and how to handle them. They also learn about the dos and don'ts when designing battery packs and possible hazards caused by design errors.

Unit 3

Battery management systems

This module touches on Battery management system design and introduces students to various battery parameters and terminologies. Students are guided towards building a battery monitoring circuit that monitors various parameters like current, voltage, temperature and energy consumption of the battery pack they have built using alkaline batteries.

Course Code	:	EV-03T
Course Title	:	EV Charging Infrastructure Technology
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	Electric Vehicles (EV)

Unit 1

Energy Management System In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies with optimization techniques used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies and implementation issues of energy management strategies.

Unit 2

Electric Vehicles Charging Station, Types of charging station, Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station, Charging Station Placement for Electric Vehicles

Unit 3

Electric Vehicle (EV) Configuration: Electric propulsion-The electronic controller, Power converter, Electric Motor (EM), Mechanical transmission, Driving wheels. Energy source-The energy source (battery, fuel cell, ultracapacitor), Energy management unit, Energy refueling unit. Auxiliary system- Power steering unit, Temperature control unit, Auxiliary power supply. EV alternatives based on drivetrains: EV configuration with clutch, gearbox and differential-I, EV configuration without clutch and gearbox, EV configuration with clutch, gearbox and differential-II

Unit 4

EV configuration with two EM, EV configuration with in wheel motor and mechanical gear, EV configuration with in wheel motor and no mechanical gear. EV alternatives based on power source configuration: EV configuration with battery source, EV configuration with two battery sources, EV configuration with battery and fuel cell source, EV configuration with multiple energy sources, EV configuration with battery and capacitors sources, EV configuration with battery and flywheel sources, Single and Multi-motor drives, In wheel drives

References

1. M. Ehsani,:Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,2005

2. K.T.Chau, Zheng Wang, Chaos in Electrical Drive Systems: Analysis, Control & Applications, 1st Edition, John Wiley and Sons, 2011

Course Code	:	EV-04T
Course Title	:	Embedded System for EV
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	Electric Vehicles (EV)

Unit I

INTODUCTION TO EMBEDDED SYSTEM Basic components of Embedded system, Programming Language Classification of Embedded system, Advantage & Disadvantage, Difference between Microprocessor & Microcontroller, Classification based on architecture, Memory Classification, Description of RAM, Description of CPU Registers, Introduction to Embedded C, Difference between C & Embedded C.

Unit 2

EMBEDDED SOFTWARE AND HARDWARE INTERFACING Kiel Compiler, Proteus, Interfacing of LED, Seven segment display, , LCD, Switches, Keyboard, Serial Communication, Sensors

Unit 3

INTRODUCTION TO IoT Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates

Unit 4

ELECTRONIC DIAGNOSTICS FOR VEHICLES System diagnostic standards and regulation requirements –On board diagnosis of vehicles electronic units & electric units-Speedometer, oil and temperature gauges, and audio system.

TEXT BOOKS:

1. William B. Ribbens,"Understanding Automotive Electronics", Elseiver,2012

2. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air And Space Vehicles" Marcel Decker, 2004.

Course Code	:	EV-05T
Course Title	:	Modelling of an Electric Vehicle
Number of Credits	:	4(L: 1; T: 0; P: 6)
Course Category	:	Electric Vehicles (EV)

Course Objective:

The course is a beginner-level course designed to introduce students to Electric vehicles andgive them a brief idea about electric vehicles, and its importance. This course gives some basic technical foundations regarding electric vehicles In-order to help them move on to advanced electric vehicle courses.

Unit 1

Introduction to Electric Vehicles 101

This module introduces the students to the relevance of electric vehicles, current demand inEV industry and opportunities of skilled EV engineers.

Unit 2

Electric Vehicle Foundations

In this module, students will learn the history and evolution of electric vehicles and what goes into building them. Students will be able to appreciate the actual impact of EVs in the world.

Unit 3

Understanding the Foundations of an Electric Vehicle

Here we look into what is considered as an electric vehicle, and what electric vehicles are made up of. This module will cover the necessary components of an electric vehicle.

Unit 3

Mathematical Modeling of an electric vehicle

In this module, students learn about modelling the conversion of an ICE vehicle to electric. They choose a target vehicle in the Indian market, finalize the vehicle specifications and simulate the energy consumption for their electric vehicle conversion using SCILAB.

By completing the course, students will be introduced to electric vehicles, their importance and identify various components of an EV.

By the end of this course, students will:

- Get introduced to electric vehicles, understand how are EVs different from ICEvehicles and identify various parts of an electric vehicle.
- Learn the fundamentals of Lithium-ion cells.
- Analyse EVs based on power sources and calculate range of an EV.

- Perform motor power and torque calculations to select a motor to build their own EV.
- Learn the basics of converting any petrol 2-wheeler into an electric vehicle.

Minor Degree in "Industrial Automation"

Course Structure						
S. No.	**Course Code**	**Title**	**L**	**T**	**P**	**Credits**
1	IA-01T	Transducer and Applications	3	0	0	3
2	IA-01P	Transducer and Applications	0	0	2	1
3	IA-02T	Process Control Instrumentation	3	0	0	3
4	IA-02P	Process Control Instrumentation	0	0	2	1
5	IA-03T	PLC and DCS	3	1	0	4
6	IA-04T	Intelligent Instrumentation	3	1	0	4
7	IA-05T	Communication Protocols for Instrumentation	3	1	0	4
TOTAL			**15**	**3**	**4**	**20**

Course Code	:	IA-01T
Course Title	:	Transducer and Applications
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	Industrial Automation

Course Outcome

The students should be able to:

1- Understand the basic principles and classification of transducers.
2- Understand the errors and analysis of those errors in measurement system.
3- Know the various static and dynamic characteristics of transducers.
4- understand selection of transducers

INTRODUCTION – Role And Importance Of Instrumentation In Various Industries, Elements of instrumentation system, Use of monitored information, Types of instrumentation systems, Standards of instrumentation design and telemetry, Industry standard for analog signal transmission, Current loop telemetry systems, Electrical Standards, Calibration.

PASSIVE TRANSDUCERS

Introduction, Transducer element- definitions, types, features; Advantages of electrical transducers, Selection of transducers, Resistive transducers - Resistive potentiometers, Resistance strain gauge, Measurement with strain gauges, Resistance temperature detectors, Piezo-resistive sensors; Inductive transducers- Inductive type transducers based on change in reluctance, mutual inductance, Linear Variable Differential Transformer; Capacitive transducers, Ultrasonic transducers, Hall effect transducers, Hall effect, Hall effect sensor, Application of Hall sensors, Primary sensors - Primary sensors for pressure- diaphragms, capsules, bellows, Bourdons and for flow-venturi, orifices, turbines.

ACTIVE AND DIGITAL TRANSDUCERS

Introduction (Details with principle, features, models, characteristics and uses of) Thermo-electric type, Piezoelectric type, Electromagnetic type, Photoelectric type, Digital transducers: encoder for speed measurement – linear, rotary; Enhanced resolution encoders; Incremental linear position optical encoders; Digital tachometers; Quartz temperature transducer; Piezoelectric / Quartz pressure transducer; Vibrating diaphragm pressure transducer;

INDUSTRIAL APPLICATIONS

Introduction, (with details of industrial transducers, application to real-life cases, limitations, selection of transducers for typical application) Temperature instrumentation with radiation fundamentals, radiation detectors: thermal and photon, automatic null-balance radiation pyrometers; Pressure and load monitoring; Flow rate and total flow monitoring; Liquid level

instrumentation; Instrumentation of mechanical variables-displacement, velocity, acceleration, vibration; Monitoring of humidity and moisture.

Text Books

1. Satya Sheel – Instrumentation – Theory and Applications.
2. Murthy, D.S. – Transducer instrumentation.

Reference Books

1. Rangan, Sarma, Mani – Instrumentation systems and devices (TMH).
2. Patranabis,D. – Principles of industrial instrumentation (TMH).
3. Parr,E.A. –Industrial control handbook vol.1 (Collins).

Course Code	:	IA-02T
Course Title	:	Process Control Instrumentation
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	Industrial Automation

Course Outcomes ;

At the end of course ,student will be able to
CO1: Understand the concept of process dynamics
CO2: Understand the concept of control action &about controller
CO3: Understand about final control elements and control valves
CO4: Understand multiloop control system and about PLC

Unit-1 Process Dynamics
Process variables, Load variables, Dynamics of simple pressure, flow level and temperature process, interacting and non-interacting systems, continuous and batch process, self-regulation, Servo and Regulator operation.

Unit-2 Control Actions and Controllers
Basic control actions – characteristics of two position, three position, Proportional, Single speed floating, Integral and Derivative control modes – PI, PD, PID control modes, Pneumatic, Hydraulic and Electronic Controllers to realize various control actions.

Tuning of controllers
Tuning: process curve reaction method, Zeigler-Nicols (Z-N), Cohen-coon tuning, lambda tuning

Unit-3 Final Control Elements

I/P Converter, P/I converter - pneumatic, electric and hydraulic actuators – valve positioned, Control valves – characteristic of control valves – valve body – Globe, Butterfly, diaphragm

Unit-4 Multiloop Control System: Feedback- Feed forward control
Feed forward control, Ratio control, Cascade control, Split range, Auctioneering control Multivariable, interaction and decoupling, Multivariable control of loops

Text Books:
1 Process Control by Curtis Johnson.
2. Process Control – Harriott P., TMH, 1991
3. Digital Control And State Variable Methods- by M Gopal TMH

References:
1. Process Control, Third Edition – Liptak B.G., Chilton Book Company, Pennsylvania, 1995
2. Process control – by Pollard A., Heinemann Educational Books, London, 1971.
3. Automatic Process Control – by Eckman D.P. , Wiley Eastern Ltd., New Delhi, 1993.
4. Process Control – by Patranabis.

Course Code	:	IA-03T
Course Title	:	PLC and DCS
Number of Credits	:	3 (L: 3; T: 0; P: 0)
Course Category	:	Industrial Automation

PLC and DCS

Course Outcome

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

(i) Understand the application of tools like PLC, DCS, and SCADA in automation.

(ii) Design the DCS for their application.

(iii) Configure of PLC and DCS.

(iv) Understand advanced design methodologies and design different controller for different types of processes.

UNIT-I: INTRODUCTION & PLC PROGRAMMING - Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC. PLC - Ladder diagram – Programming timers and counters – Design of PLC-Instructions in PLC – Program control instructions, math instructions and sequencer instructions.

UNIT-II: - PROGRAMMABLE LOGIC CONTROLLERS - Introduction of Advanced PLC programming, Selection of processor, Input/output modules, Interfacing of Input/output devices, Operator Interface, OPC, study of SCADA software, Interfacing of PLC with SCADA software.

UNIT-III: - AUTOMATION SPECIFICATIONS - DCS Project: Development of User Requirement Specifications, Functional Design Specifications for automation tool, GAMP, FDA

UNIT-IV: - Distributed Control System - Introduction to architecture of different makes, DCS Specifications, configuration of DCS blocks for different applications, Interfacing of protocol based sensors, actuators and PLC systems, Plant wide database management, Security and user access management, MES, ERP Interface.

UNIT-V: - CASE STUDY - Study of Advanced Process control blocks: Statistical Process Control, Model Predictive Control, Fuzzy Logic Based Control, Neural-Network Based Control, Higher Level Operations: Control & Instrumentation for process optimization Applications of the above techniques to the standard units/processes

TEXT BOOKS

1.Gary Dunning, Introduction to Programmable logic Controllers, Thomson / Delmar Learning, 2005. 2.Webb, Reis, Programmable logic Controllers: principles and applications, Prentice Hall of India, 2002.
3.Jose A. Romagnoli, Ahmet Palazoglu, Introduction to process Control, CRC Tylor and Francisgroup, 2005.

REFERENCE BOOKS

1.John. S. Oakland, Statistical Process Control, Butterworth – Heinemann, 2007.
2.B.G Liptak, Instrument Engineer's Handbook : Process Control and Optimization, Chilton Book Company, 2005
3.Installation and user manuals of different DCS, PLC Vendors

Course Code	:	IA-04T
Course Title	:	Intelligent Instrumentation
Number of Credits	:	4 (L: 3; T: 1; P: 0)
Course Category	:	Industrial Automation

- INTRODUCTION

Introduction to intelligent instrumentation, Historical Perspective, Current status, software based instruments.

- FUZZY LOGIC CONTROLLER

Functional diagram, membership functions: triangular, trapezoidal- scale factors. Fuzzification: membership value assignments using intuition –knowledge base. Defuzzification: max-membership principle – centeroid method – weighted average method – rule. Choice of variables-derivation of rules- case study: fuzzy logic controller design for a temperature process.

- ARTIFICIAL NEURAL NETWORKS

Artificial Neuron models, Types of activation functions, Neural network architectures, Neural Learning: correlation, competitive, feedback based weight adaptation, evaluation of networks, quality of results, generalizability, computational resources, Supervised learning: perceptrons, linear separability, Multilayer networks, backpropagation algorithm and its varianta, Unsupervised learning, winner-take all networks, adaptive resonance theory, Self organizing maps, Hopfield networks, Boltzman machines, Support Vector Machine, Typical application in identification, optimization, pattern recognition, etc.

- DATA ACQUISITION METHODS

Analog and Digital IO, Counters, Timers, Basic ADC designs, interfacing methods of DAQ hardware, software structure, use of simple and intermediate Vis. Use of Data Sockets for Networked communication and controls.

- PC HARDWARE REVIEW AND INSTRUMENTATION BUSES

Structure, timing, interrupts, DMA, operating system, ISA, PCI, USB, PCMCIA Buses. IEEE488.1 & 488.2 serial, Interfacing-RS 232C,RS422, RS423, RS485, USB, VXI, SCXI, PXI.

Text Books

1. G. C. Barney, “Intelligent Instrumentation”, Prentice Hall, 1995.
2. Lisa, K. Wells & Jeffery Travis, “Lab VIEW For every one”, Prentice Hall, 1997.
3.Timothy J. Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill, New York.
4.Hagan, et. al., “Neural Network Design”, Cengage.

Course Code	:	IA-05T
Course Title	:	COMMUNICATION PROTOCOLS FOR INSTRUMENTATION
Number of Credits	:	4 (L: 3; T: 1; P: 0)
Course Category	:	Industrial Automation

Course Outcome

After completion of the course the students are expected to be able to:

(i) Comprehend in the Networks in process automation, Data Communication basics, OSI reference model, Industry Network, Recent networks.

(ii) Classify and understand the Communication Protocols, Communication basics, Network Classification, Network selection.

(iii) Explain the Proprietary and open networks: Network Architectures, Industry open protocols (RS-232C, RS422, and RS-485), Ethernet, Modbus, Modbus Plus, and Data Highway Plus.

(iv) Understand the Advantages and Limitations of Open networks, IEEE 1394.

UNIT-I: - INTRODUCTION - An Introduction to Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Recent networks.

UNIT-II: - COMMUNICATION PROTOCOLS - Introduction to Communication Protocols: Communication basics, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection.

UNIT-III: - NETWORK ARCHITECTURES - Proprietary and open networks: Network Architectures, Building blocks, Industry open protocols (RS232C, RS- 422, and RS-485), Ethernet, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations of Open networks, IEEE 1394. 85

UNIT-IV: -FIELD BUS - Field bus: Field bus Trends, Hardware selection, Field bus design, Installation, Documentation, Field bus advantages and limitations. HART: Introduction, Design, Installation, calibration, commissioning, Application in Hazardous and Non-Hazardous area.

UNIT-V: - PLANNING AND COMMISSIONING - Foundation Field bus & Profibus: Introduction, Design, Calibration, Commissioning, Application in Hazardous and Non-Hazardous area. Introduction to wireless Protocols: WPAN, Wi-Fi, Bluetooth, ZigBee,

TEXT BOOKS 1.B.G. Liptak, „Process Software and Digital Networks, CRC Press ISA-, 2002.

REFERENCE BOOKS: 1.Romilly Bowden,„HART Communications Protocol", Fisher-Rosemount, 2003. 2.User Manuals of Foundation Field bus, Profibus, Modbus, Ethernet, Device net, and Control net.