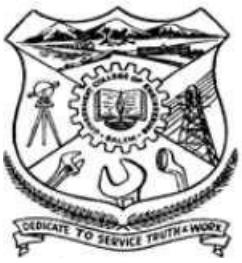

GOVERNMENT COLLEGE OF ENGINEERING
SALEM – 636 011

(An Autonomous Institution affiliated to Anna University- Chennai)

Regulations 2022 – Autonomous Courses(For Students Admitted from 2022 – 2023)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM & SYLLABUS

(Choice based credit system)

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING (P.T)

GOVERNMENT COLLEGE OF ENGINEERING SALEM – 636011
(An Autonomous Institution, Affiliated to Anna University, Chennai)

Regulations 2022 – Autonomous Courses
(For Students Admitted from 2022-2023)

B.E. ELECTRONICS AND COMMUNICATIO ENGINEERING - PART TIME

SEMESTER I

Sl. No	Course Code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
THEORY										
1.	22PTMA101	Matrices and Calculus	BS	3	0	0	3	40	60	100
2.	22PTEC101	Semiconductor Devices and Circuits	PC	3	0	0	3	40	60	100
3.	22PTEC102	Digital System Design	PC	3	0	0	3	40	60	100
4.	22PTEC103	Network Theory	PC	3	0	0	3	40	60	100
	PRACTICAL									
5.	22PTEC104	Electronic Devices and Digital Electronics	PC	0	0	3	1.5	60	40	100
		TOTAL		**12**	**0**	**0**	**13.5**	**220**	**280**	**500**

SEMESTER II

THEORY

Sl. No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
1.	22PTMA201	Linear Algebra, Partial Differential Equation and Vector Calculus	HS	3	0	0	3	40	60	100
2.	22PTEC201	Analog Circuits	BS	3	0	0	3	40	60	100
3.	22PTEC202	Electronics and Measurement	PC	3	0	0	3	40	60	100
4.	22PTEC203	Signals and Systems	PC	3	0	0	3	40	60	100
PRACTICAL										
5.	22PTEC204	Analog Circuits Laboratory	PC	0	0	3	1.5	60	40	100
		TOTAL		**12**	**0**	**3**	**13.5**	**220**	**280**	**500**

SEMESTER III										
THEORY										
Sl. No	**Course code**	**Name of the Course**	**Hours/week**					**Maximum Marks**		
			Category	**Lecture**	**Tutorial/ Demo***	**Practical**	**Credits**	**CA**	**FE**	**Total**
1.	22PTEC301	Analog Communication	PC	3	0	0	3	40	60	100
2.	22PTEC302	Control System	PC	3	0	0	3	40	60	100
3.	22PTEC303	Antenna and Wave Propagation	PC	3	0	0	3	40	60	100
4.	22PTEC304	Microprocessor and Microcontroller	PC	3	0	0	3	40	60	100
PRACTICAL										
5.	22PTEC305	Microprocessor and Microcontroller Laboratory	EEC	3	0	0	1.5	60	40	100
		TOTAL		**15**	**0**	**0**	**13.5**	**220**	**280**	**500**

SEMESTER IV										
THEORY										
Sl. No	**Course code**	**Name of the Course**	**Hours/week**					**Maximum Marks**		
			Category	**Lecture**	**Tutorial/ Demo***	**Practical**	**Credits**	**CA**	**FE**	**Total**
1.	22PTEC401	Digital Communication	PC	3	0	0	3	40	60	100
2.	22PTEC402	Digital Signal Processing	PC	3	0	0	3	40	60	100
3.	22PTEC403	Embedded System	PC	3	0	0	3	40	60	100
4.	22PTEC404	Energy and Environmental Science	BS	2	0	0	2	40	60	100
PRACTICAL										
5.	22PTEC405	Analog and Digital Communication Laboratory	EEC	0	0	3	1.5	60	40	100
		TOTAL		**11**	**0**	**3**	**12.5**	**220**	**280**	**500**

SEMESTER V										
THEORY										
Sl. No	**Course Code**	**Name of the Course**	**Hours/week**					**Maximum Marks**		
			Category	**Lecture**	**Tutorial/ Demo***	**Practical**	**Credits**	**CA**	**FE**	**Total**
1.	22PTEC701	Principles of Management	PC	3	0	0	3	40	60	100
2.	22PTEC501	Wireless Communication	PC	3	0	0	3	40	60	100

3.	22PTEC502	VLSI Design	PC	3	0	0	3	40	60	100
4.	22PTEC503	Microwave and Optical Communication	PC	3	0	0	3	40	60	100
PRACTICAL										
5.	22PTEC504	VLSI and Embedded System Laboratory	EEC	0	0	3	1.5	60	40	100
		TOTAL		**12**	**0**	**3**	**13.5**	**220**	**280**	**500**

SEMESTER VI

THEORY

Sl. No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
1.	22PTECEXX	Professional Elective - I	PC	3	0	0	3	40	60	100
2.	22PTECEXX	Professional Elective - II	PC	3	0	0	3	40	60	100
3.	22PTECEXX	Professional Elective - III	PC	3	0	0	3	40	60	100
4.	22PTECEXX	Professional Elective - IV	PC	3	0	0	3	40	60	100
5.	22PTECEXX	Professional Elective - V	PC	3	0	0	3	40	60	100
		TOTAL		**15**	**0**	**0**	**15**	**200**	**300**	**500**

SEMESTER VII

THEORY

Sl. No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
1.	22PTEC701	Mobile Communication	PC	3	0	0	3	40	60	100
2.	22PTECEXX	Professional Elective - VI	PC	3	0	0	3	40	60	100
3.	22PTECEXX	Professional Elective - VII	PC	3	0	0	3	40	60	100
PRACTICAL										
4.	22PTECE702	Project Work	EEC	0	0	6	10	120	80	200
		TOTAL		**12**	**0**	**6**	**19**	**240**	**260**	**500**

Total number of credits to be earned for the award of degree = 100.5

Electronics and Communication Engineering Scheme of Credits

Course Work	Credits Recommended by AICTE	Credit % for AICTE Recommendation	Credits	Credit %
Humanities and Social Sciences	12	7.5	6	3.60
Basic Science	25	15.63	30	18.02
Engineering Science	24	15	16.5	9.94
Program Core	48	30	70	42.04
Program Electives	18	11.25	18	10.80
Open Electives	18	11.25	12	7.20
Employment Enhancement Courses	15	9.38	14	8.40
Mandatory Courses (Zero Credit)	-	-	-	-
Total	160	100.00	100.50	100.00

HS	Humanities and Social Science
BS	Basic Science
ES	Engineering Science
PC	Program Core
PE	Program Electives
OE	Open Electives
EEC	Project Work

LIST OF ELECTIVES FOR B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Professional Electives (PE)

Sl. No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
Semester – VI		**PROFESSIONAL ELECTIVE - I**								
1.	22PTECPE601	Electronic Measurements	BS	3	0	0	3	40	60	100
2.	22PTECPE602	Computer Architecture	PC	3	0	0	3	40	60	100
3.	22PTECPE603	Digital Image Processing	PC	3	0	0	3	40	60	100
4.	22PTECPE604	Artificial Intelligence & Machine Learning	PC	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE - II										
5.	22PTECPE605	Modern Sensors and its Applications	PE	3	0	0	3	40	60	100
6.	22PTECPE606	Radar Communication	PE	3	0	0	3	40	60	100
7.	22PTECPE607	Internet of Things	PE	3	0	0	3	40	60	100
8.	22PTECPE608	Nano Electronics	PE	3	0	0	3	40	60	100
PROFESSIONAL ELECTIVE - III										
9.	22PTECPE609	Software Defined Radio	PE	3	0	0	3	40	60	100
10.	22PTECPE610	Advanced Radiating System	PE	3	0	0	3	40	60	100
11.	22PTECPE611	Robotics	PE	3	0	0	3	40	60	100
12.	22PTECPE612	Virtual Instrumentation	PE	3	0	0	3	40	60	100
Semester - VII		**PROFESSIONAL ELECTIVE - IV (Industry Elective)**								
13.	22PTECPE701	Automotive Electronics	PE	3	0	0	3	40	60	100
14.	22PTECPE702	Embedded C	PE	3	0	0	3	40	60	100
15.	22PTECPE703		PE	3	0	0	3	40	60	100
16.	22PTECPE704		PE	3	0	0	3	40	60	100
Semester - VII		**PROFESSIONAL ELECTIVE - V**								
17.	22PTECPE801	Multimedia Compression and Communication Technical	PE	3	0	0	3	40	60	100
18.	22PTECPE802	Wireless Sensor Networks	PE	3	0	0	3	40	60	100
19.	22PTECPE803	Telecommunication and Switching	PE	3	0	0	3	40	60	100
20.	22PTECPE804	Deep Learning	PE	3	0	0	3	40	60	100
Semester - VII		**PROFESSIONAL ELECTIVE - V**								

21.	22PTECPE805	Network Security	PE	3	0	0	3	40	60	100
22.	22PTECPE806	Satellite Communication	PE	3	0	0	3	40	60	100
23.	22PTECPE807	Bio Medical Electronics	PE	3	0	0	3	40	60	100
24.	22PTECPE808	Microwave Integrated Circuits	PE	3	0	0	3	40	60	100

OPEN ELECTIVES (OE) [For other Departments]

Sl. No	Course code	Name of the Course	Hours/week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
1.	18ECOE01	Fundamentals of Electron Devices	OE	3	0	0	3	40	60	100
2.	18ECOE02	Principles of Modern Communication S	OE	3	0	0	3	40	60	100
3.	18ECOE03	Microcontroller and its Applications	OE	3	0	0	3	40	60	100
4.	18ECOE04	Basics VLSI Design	OE	3	0	0	3	40	60	100
5.	18ECOE05	Basic of Embedded Systems	OE	3	0	0	3	40	60	100
6.	18ECOE06	Basics of Internet of Things	OE	3	0	0	3	40	60	100

22PTMA101	MATHEMATICS – I		Semester			I
PREREQUISITES		**Category**	**BS**	**Credit**		**3**
Basic 12th level knowledge of ODE, PDE, Vector algebra and Complex Analysis.		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
2	To make the student to understand the techniques in solving partial differential equations that model engineering problems.
3	To acquaint the student with the concepts of vector calculus, needed for solving engineering problems.
4	To understand the concept of analytic functions.
5	To obtain the knowledge of complex integration

UNIT I	**ORDINARY DIFFERENTIAL EQUATIONS**	**9**	**0**	**0**	**9**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations.

UNIT II	**PARTIAL DIFFERENTIAL EQUATIONS**	**9**	**0**	**0**	**9**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Homogeneous Linear partial differential equations of second order with constant coefficients.

UNIT III	**VECTOR CALCULUS**	**9**	**0**	**0**	**9**

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Statement of Gauss divergence theorem and Stokes theorem – Simple applications involving cubes and rectangular parallelopipeds.

UNIT IV	**ANALYTIC FUNCTIONS**	**9**	**0**	**0**	**9**

Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and sufficient conditions (excluding proofs) – Properties of analytic function – Harmonic conjugate – construction of analytic functions – Conformal mapping: $w = z + c,\ cz,\ \frac{1}{z}$ and bilinear transformation.

UNIT V	**COMPLEX INTEGRATION**	**9**	**0**	**0**	**9**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's expansions – Singular points – residues – Residue theorem – Application of residue theorem to evaluate real integrals over semi-circular contours (excluding poles on boundaries).

Total (45 L + 0 T) = 45 Periods

Text Books:

1	Grewal. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2015.
2	P. Kandasamy, K. Thilagavathy and K. Gunavathy, "Engineering Mathematics (For I year B. E, B. Tech)", Ninth Edition, S. Chand & Co. Ltd., New Delhi, 2010.

Reference Books:

1	James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, New Delhi, 2008.

2	Veerarajan T., "Engineering Mathematics (For semester I and II)", 5th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.
3	Erwin Kreyszig, "Advanced Engineering Mathematics", 7th Edition, Wiley India, 2007.
4	Jain R.K. and Iyengar S.R.K, "Advanced Engineering Mathematics", 3rd Edition, Narosa Publishing House Pvt. Ltd., 2007.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Find the techniques of solving ordinary differential equations that arise in engineering problems.	L3
CO2	Find the techniques of solving partial differential equations that arise in engineering problems.	L3
CO3	Apply the concept of vector calculus and vector integration.	L3
CO4	Understand analytic function and its properties.	L2
CO5	Evaluate various integrals by using Cauchy's residue theorem.	L5

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO2	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO3	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO4	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO5	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
Avg	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)															

22PTEC101	SEMICONDUCTOR DEVICES AND CIRCUITS	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the fundamentals of electron devices and circuits.
2	To design and analyze single stage and multistage amplifier circuits.
3	To understand and classify different kinds of power and feedback amplifiers.

Unit I	SEMICONDUCTOR DIODES	9	0	0	9

PN junction diode – Current equations – Energy Band diagram – Diffusion and drift current densities – forward and reverse bias characteristics – Transition and Diffusion Capacitances – Switching Characteristics – Breakdown in PN Junction Diodes – Schottky barrier diode – Zener diode – Varactor diode –Tunnel diode – Photodiode.

Unit II	DIODE APPLICATIONS AND POWER SUPPLY	9	0	0	9

Clipper and clamper circuits, Half-wave, full-wave and bridge rectifiers with resistive load. Analysis for Vdc and ripple voltage with C, L, L-C and C-L-C filters. Voltage multipliers, Voltage Regulators – Zener diode regulator. Switched Mode Power Supply (SMPS).

Unit III	TRANSISTOR AMPLIFIERS	9	0	0	9

Bipolar Junction Transistor-device structure and physical operation – Current-Voltage characteristics – Ebers-Moll Model – MOSFET-device structure and physical operation – Current-Voltage characteristics – Biasing schemes for BJT and FET amplifiers – bias stability – various configurations (such as CE/CS, CB/CG, CC/CD) and their features.

Unit IV	FREQUENCY RESPONSE OF AMPLIFIERS	9	0	0	9

Small signal operation and models of MOSFET and BJT – general shape of frequency response of amplifiers – Low-Frequency Response of Discrete-Circuit Common-Source and Common-Emitter Amplifiers – Internal Capacitive Effects and the High-Frequency Model of the MOSFET and the BJT – High-Frequency Response of the CS and CE Amplifiers – General expression for frequency response of multistage amplifiers - Calculation of overall upper and lower cut off frequencies of multistage amplifiers.

Unit V	POWER AND FEEDBACK AMPLIFIERS	9	0	0	9

Power amplifiers-various classes of operation (Class A, Class B, Class AB, and Class C), their power-conversion efficiency and power dissipation calculations – cross-over distortion – Feedback topologies: Voltage series, current series, voltage shunt, current shunt – effect of feedback on gain, bandwidth etc., calculation with practical circuits – concept of stability, gain margin and phase margin.

Total(L+T) =45 Periods

Text Books:

1	A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.
2	S. Salivahanan and N. Suresh kumar, “Electronic Devices and Circuits”, Fourth edition, McGraw Hill Education, 2017.

Reference Books:

1	Donald A. Neamen. “Semiconductor Physics and Devices” 4th Edition, McGraw Hill Education 2017.
2	Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” 11th edition, PHI, 2017.

3	Ben G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson, 2015.
4	David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5th Edition, 2010.
E-References:	
1.	https://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/117103063
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the characteristics of diodes and special semiconductor devices.	L2
CO2	Design and analyze clipper, clamper and power supply circuits	L3
CO3	Acquire knowledge on working principles, characteristics and applications of BJT and FET.	L1
CO4	Analyze the frequency response characteristics of amplifiers.	L4
CO5	Design and analyze power and feedback amplifiers and derive their performance specifications.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	3	1	2	1								1		1
CO2	3	3	2	3	2								2	1	2
CO3	3	2	2	3	3								1	1	1
CO4	2	3	2	3	3								2	2	2
CO5	2	3	2	3	3								2	1	2
Avg	2.2	2.8	1.8	2.8	2.4								1.6	1	1.6
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC102	DIGITAL SYSTEM DESIGN	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Understand the number system, logic families and Boolean Algebra.
2	Understand and design combinational and sequential circuits.
3	Understand the concept of Memories and Programmable Logic Devices and apply the knowledge of these devices in design Digital electronic circuits.

Unit I	NUMBER SYSTEMS AND LOGICGATES	9	0	0	9

Binary–Decimal–Octal-Hexadecimal-Binary codes: BCD–Gray code-Boolean Algebra and Minimization Techniques-Canonical forms–Conversion between canonical forms–Simplifications of Boolean expressions Using Karnaugh map–Logic Gates: Implementations of Logic Functions using gates.

Unit II	COMBINATIONALCIRCUITS	9	0	0	9

Design procedure–Adders/Subtractor–Serialadder/Subtractor-Paralleladder/Subtractor-Carry look ahead adder-BCDadder-Multiplexer/Demultiplexer-Encoder/Decoder–Implementation of combinational logic using MUX and Decoder.

Unit III	SEQUENTIAL CIRCUITS	9	0	0	9

Design Procedure-Flip flops: SR ,JK,T,D and JK Master Slave–Moore and Mealy circuits–Counters: Asynchronous/Ripple counters–Synchronous counters–Modulo n counter–Design of Synchronous counters–Register-Shift registers-Universal shift register.

Unit IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS	9	0	0	9

Design of fundamental model circuits–Primitive state/flow table–Minimization of primitive state table–state assignment–Excitation table– Excitation map- Problems in Asynchronous Circuits: Cycles–Races–Hazards-Design of Hazard Free Switching Circuits.

Unit V	MEMORY DEVICES	9	0	0	9

Classification of memories –RAM organization – ROM organization – Flash Memory - Programmable Logic Devices: Programmable Logic Array (PLA)-Programmable Array Logic (PAL) - Implementation of combinational logic using ROM, PAL and PLA.

Total(L+T) =45 Periods

Text Books:

1	M. Morris Mano, "DigitalDesign",4th Edition, Pearson Education (Singapore)Pvt. Ltd., NewDelhi,2008.
2	R.P. Jain, "ModerndigitalElectronics", TataMcGrawHill, 4th Edition,2009

Reference Books:

1	W.H. Gothmann,"DigitalElectronics-Anintroductiontotheoryandpractice", PHI,2nd edition,,2006.
2	D.V. Hall, "Digital Circuits and Systems" Tata McGraw Hill, 1989

3	S.SalivahananandS.Arivazhagan,"DigitalCircuitsandDesign",2nd edition,VikasPublishingHousePvt.Ltd,NewDelhi,2004.
4	Charles H. Roth."Fundamentals of Logic Design", Thomson PublicationCompany,2003.
E-References:	
1.	http://nptel.ac.in/noc/individual_course.php?id=noc15-ec01
2.	https://nptel.ac.in/courses/117105080/6
3.	https://nptel.ac.in/courses/117105080/12

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the number system and the functioning of logic gates with various logic families.	L2
CO2	Design and analyze combinational logic circuits and Logic gates.	L4
CO3	Design the sequential logic circuits using Flip flops.	L2
CO4	Design and analyze asynchronous sequential logic circuits.	L4
CO5	Understand the concepts of memories and PLDs and implementation of circuits using memory and PLDs.	L1

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	3	2	3	2					1	1	
CO2	3	3	2	2	3	3	2	1	1				1		2
CO3	2	2	3	3	2	1	2	1	1					2	
CO4	2	1	2	1	2	2	3	1					1		2
CO5	2	1	2	1	3	2	1	2					2	1	
Avg	2.4	1.8	2.2	1.8	2.6	2	2.2	1.4	0.4				1	0.8	0.8
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTCY101	ENVIRONMENTAL SCIENCE AND ENGINEERING	Semester			I
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives -To make the students conversant with the

1	Principles of environmental resources.
2	Preservation of ecosystem and biodiversity.
3	Principles of environmental threats and pollution.
4	Principles of solid waste management.
5	Environmental issues and ethics.

UNIT I	ENVIRONMENTAL RESOURCES	9	0	0	9

Forest resources – importance, deforestation – water resources – hydrological cycle – food resources – effects of modern agriculture, fertilizers, pesticides – Land Resources- Land degradation-soil erosion- Mineral resources –types – mining - environmental effects of extracting and using mineral resources.

UNIT II	ECOSYSTEM AND BIODIVERSITY	9	0	0	9

Environment – biotic and abiotic components – Ecosystem – components –Energy Partitioning in Food Chains and Food Webs -tropic levels – energy flow in ecosystem, ecological pyramids – ecological succession, types – Biodiversity, types, values of biodiversity, hot spots of biodiversity, threat to biodiversity, endangered and endemic species, conservation of biodiversity – In-situ and Ex-situ conservation.

UNIT III	ENVIRONMENTAL POLLUTION	9	0	0	9

Air pollution – classification of air pollutants - gaseous, particulates – sources, effects and control of gaseous pollutants, SO_x, NO_x, H_2S, CO and particulates – control methods – catalytic convertor, cyclone separator, electrostatic precipitator– Water pollution – heavy metal ions pollutants – organic pollutants, oxygen demanding wastes, aerobic and anaerobic decomposition, Dissolved oxygen (DO), BOD and COD - experimental determination of BOD only, treatment of domestic and industrial wastewater – Noise pollution –decibel scale - sources, effects and control measures.

UNIT IV	ENVIRONENTAL THREATS AND SOLID WASTE MANAGEMENT	9	0	0	9

Eutrophication, bio amplification, acid rain, greenhouse effect and global warming, ozone layer depletion, photo chemical smog – disaster management – origin, effects and management of earthquake and floods. Solid waste management – solid wastes, classification, origin, effects – treatment methods – composting, sanitary land filling – destructive methods – incineration, pyrolysis, 3R (reduce, reuse and recycling).

UNIT V	SOCIAL ISSUES AND ENVIRONMENTAL ETHICS	9	0	0	9

From unsustainable to sustainable development, objectives, and ways of achieving – urban problems related to energy and energ conservation – water conservation and management, rainwater harvesting – waste land reclamation. Environmental ethics consumerism – human population, exponential and logistic growth, population explosion, population policy, family welfar programme – population control methods – HIV and AIDS.

Total (45L+0T) = 45 Periods

Text Books:

1	Elements of Environmental science and Engineering, P.Meenakshi, Prenitce — Hall of India, New Delhi, 2009.

2	A Textbook of Environmental Chemistry and Pollution Control: (With Energy, Ecology, Ethics and Society), Revise Edition, Dr. S.S. Dara, D.D. Mishra Published by S. Chand & Company Ltd, 20 14.
Reference Books:	
1	Introduction to Environmental Engineering and Science, Gilbert M. Masters; Wendell P. Ela Publisher: Prentice-Hall India, 3rd Edition, 2008.
2	Environmental Science, F;ldren D. Enger, Bredley F.Smith, WCD McGraw Hill 14"Edition 2015.
E-References:	
1.	www.onlinecourses.nptel.ac.in/
2.	www.ePathshala.nic.in

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Play an important role in conservation of natural resources for future generation.	L6
CO2	Paraphrase the importance of ecosystem and biodiversity.	L2
CO3	Analyze the impact of pollution and hazardous waste in a global and social context.	L4
CO4	Understand contemporary issues that result in environmental degradation that would attempt to provide solutions to overcome the problems.	L2
CO5	Consider the issues of environment and human population in their professional undertakings.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	0	0	1	3	2	0	0	0	1	2	0	1
CO2	3	3	2	0	0	1	3	2	0	0	0	1	2	0	1
CO3	3	3	2	0	0	1	3	2	0	0	0	1	2	0	1
CO4	3	3	2	0	0	1	3	2	0	0	0	1	2	0	1
CO5	3	3	2	0	0	1	3	2	0	0	0	1	2	0	1
Avg	3	3	2	0	0	1	3	2	0	0	0	1	2	0	1
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC103	SEMICONDUCTOR DEVICES AND DIGITAL ELECTRONICS LABORATORY	Semester	I

PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To provide an insight into the characteristics of electron devices.
2	To design and analyze various amplifier circuits.
3	To study the operation of combinational and sequential logic circuits.

EXPERIMENTS

1.	Characteristics of PN Junction Diode and Zener Diode
2.	Design of Clippers and Clampers.
3.	Measurement of ripple factor of Rectifiers with and without capacitor filter.
4.	Characteristics of CE/CB/CC configurations of Bipolar transistors.
5.	Characteristics of MOSFET.
6.	Frequency response of BJT Amplifier using voltage divider bias (self-bias) with and without emitter bypass capacitor.
7.	Frequency response of Multi stage amplifiers.
8.	Determination of efficiency of Class A power amplifier.
9.	Design and Analysis of Series feedback amplifiers.
10.	Design and Analysis of Shunt feedback amplifiers.
11.	Study of Logic Gates, Study of Flip-Flops using Logic Gates
12.	Design and implementation of Multiplexer and De-multiplexer using logic gates.
13.	Design and implementation of encoder and decoder using logic gates
14.	Construction and verification of 4bit ripple counter and Mod-10/Mod-12 Ripple counters
15.	Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops

Total(L+T) =45 Periods

References:

1	A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford University Press, 2017.
2	S. Salivahanan and N. Suresh kumar, “Electronic Devices and Circuits”, Fourth edition, McGraw Hill Education, 2017.

Reference Books:

1	Robert L. Boylestad, Louis Nashelsky and Franz Monssen, “Electronic Devices and Circuit Theory Lab Manual”, Pearson Prentice Hall, 2012.

2	Ben G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2015.
3	S.Poorna Chandra, B.Sasikala, "Electronics Laboratory Primer", S.Chand& Company Ltd, 2010.
4	L.K. Maheshwari, M.M.S. Anand, "Laboratory Manual for Introductory Electronics Experiments", New age International (P) Limited Publishers, 2010.
E-References:	
1.	https://nptel.ac.in/courses/108108112
2.	https://nptel.ac.in/courses/108101091
3.	http://www.electronics-tutorials.ws/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Analyze the characteristics of diodes and transistors.	L4
CO2	Design electronic circuits such as rectifiers and analyse their performance.	L3
CO3	Analyze the frequency response of small signal, power and feedback amplifiers using discrete components.	L4
CO4	Design and Construct combinational and sequential logic circuits.	L3
CO5	Implement electronic circuits and test their performance.	L5

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	2	2								1		1
CO2	3	3	2	2	2								2	1	1
CO3	3	3	2	2	2								2	1	2
CO4	3	3	3	2	2								1		1
CO5	3	3	3	2	2								2	2	2
Avg	2	3	2	2	2								1		1
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTMA201	MATHEMATICS – II	Semester			II
PREREQUISITES	**Category**	**BS**	**Credit**		**3**
Basic 12th level knowledge of Differential Calculus, Integral Calculus and ODE	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To introduce the concept of Fourier series.
2	To understand the application of Fourier analysis in solving boundary value problems.
3	To obtain the knowledge of solving second order ODE using Laplace transform techniques and inverse Laplace transform using convolution theorem.
4	To familiarize with Fourier, transform of a function and its sine and cosine transforms.
5	To gain the skills to form difference equations and find its solution by using Z-transform method.

UNIT I	**FOURIER SERIES**	**9**	**0**	**0**	**9**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's Identity

UNIT II	**BOUNDARY VALUE PROBLEMS**	**9**	**0**	**0**	**9**

Classification of second order quasi linear partial differential equations – Solutions of one-dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation for infinite plates (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

UNIT III	**LAPLACE TRANSFORM**	**9**	**0**	**0**	**9**

Laplace Transform- Conditions for existence – Transform of elementary functions – Basic Properties – Transform of derivatives and integrals – Initial and Final value theorems- Transform of periodic Functions – Inverse Laplace Transform- statement and application of convolution theorem.

UNIT IV	**FOURIER TRANSFORM**	**9**	**0**	**0**	**9**

Statement of Fourier integral theorem – Fourier transforms pair – Sine and Cosine transforms Properties – Transforms of simple functions – Parseval's Identity.

UNIT V	**Z -TRANSFORM AND DIFFERENCE EQUATIONS**	**9**	**0**	**0**	**9**

Z-transform of simple functions and properties – Inverse Z – transform –initial and final value theorems- Convolution theorem - Solution of difference equations using Z – transform technique.

Total (45 L + 0 T) = 45 Periods

Text Books:

1	Veerarajan T, "Engineering Mathematics (For Semester III)", 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.
2	P. Kandasamy, K. Thilagavathy and K. Gunavathy, "Engineering Mathematics, Volume III", S. Chand & Company Ltd., New Delhi, 1996.

Reference Books:

1	Grewal, B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.

2	Wylie C. Ray and Barrett Louis, C., "Advanced Engineering Mathematics", Sixth Edition, McGraw-Hill, Inc., New York, 1995.
3	Andrews, L.A., and Shivamoggi B.K., "Integral Transforms for Engineers and Applied Mathematicians", MacMillan, New York, 1988.
4	Narayanan, S., Manicavachagom Pillai, T.K. and Ramaniah, G., "Advanced Mathematics for Engineering Students", Volumes II and III, S. Viswanathan (Printers and Publishers) Pvt. Ltd. Chennai, 2002.

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Acquire the knowledge about Fourier series.	L2
CO2	Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.	L3
CO3	Apply the knowledge of Laplace transforms method to solve second order differential equations.	L3
CO4	Apply the knowledge of Fourier transform in engineering problems.	L3
CO5	Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO2	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO3	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO4	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
CO5	3	2	0	2	0	0	0	0	0	0	0	0	2	0	0
Avg	**3**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC201	ANALOG CIRCUITS	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To give a comprehensive exposure to all types of discrete amplifiers and oscillators.To develop astrong basis for linear and digital integrated circuits.
2	To understand the various linear and non-linear applications of op-amp.
3	To understand the operation of the D/A &A/D converter types and its applications.

Unit I	OSCILLATORS	9	0	0	9

Feedback Amplifier: Block diagram - Gain with feedback - Barkhausen Criterion - Mechanism for start of oscillation and stabilization of amplitude -RC phase shift Oscillator - Wien bridge Oscillator and Twin-T Oscillators - Analysis of LC Oscillators: Colpitts – Hartley – Clapp oscillators.

Unit II	TUNED AMPLIFIERS AND MULTIVIBRATORS	9	0	0	9

Analysis of single tuned and synchronously tuned amplifiers - Class C tuned amplifiers and their applications - Efficiency of Class C tuned Amplifier- Collector coupled and Emitter coupled Astable Multivibrator – Monostable Multivibrator – Bistable Multivibrator - Monostable and Astable Blocking Oscillators using Emitter timing.

Unit III	CIRCUIT FOR LINEARIC'S	9	0	0	9

Current mirror: Basic topology and its variants - Differential amplifier: Basic structure and principle of operation - Calculation of differential gain - Common Mode gain, CMRR - OP-AMP design -Design of Differential amplifier - Design of gain stages and output stages – compensation - DC and AC characteristics of OP-AM - slew rate.

Unit IV	APPLICATIONS OF OPERATIONAL AMPLIFIER	9	0	0	9

Inverting and non-inverting amplifiers - Integrator and Differentiator - Summing amplifier - Precision rectifier - Schmitt trigger and its applications - Active filters: Low pass, high pass, band pass and band stop filters - Sine wave oscillators – Comparator - Multivibrator.

Unit V	DATA CONVERTERS AND SPECIAL FUNCTIONICs	9	0	0	9

Digital-to-Analog converters (DAC): Weighted resistor - R-2R ladder - . Analog to-Digital converters (ADC): Single slope -dual slope - Successive Approximation - Flash type - IC 555 timer and its applications - IC723 Voltage regulators.

Total(L+T) =45 Periods

Text Books:

1	B.VisvesvaraRao,K.RajaRajeswari,P.ChalamRajuPantulu,K.BhaskaraRamaMurthy,"ElectronicCircuits-II",PearsonEducation,2012
2	D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits" ,New Age International Pvt.Ltd.,2011.

Reference Books:

1	Millman J. and TaubH., "Pulse Digital and Switchingwaveform",3rdEdition, McGraw-HillInternational, 2011.
2	Sedera & Smith, "Micro ElectronicCircuits",4thEdition, Oxford University Press ,Chennai.

3	Michael Jacob, 'Applications and Design with Analog Integrated Circuits', Prentice Hall ofIndia,1996..
4	K.R .Botkar, 'Integrated Circuits',10th edition, KhannaPublishers,2010.
E-References:	
1.	http://nptel.ac.in/courses/117105080/40
2.	http://freevideolectures.com/Course/2915/Linear-Integrated-Circuits
3.	http://nptel.ac.in/courses/117108038/1

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Analyze different types of amplifier, oscillator and multivibrator circuits.	L4
CO2	Construct and analyze tuned amplifiers and multivibrators.	L4
CO3	Develop competence in linear and non linear Op amp circuit analysis.	L3
CO4	Understand the concepts of waveform generation and introduce somespecial function ICs	L2
CO5	Differentiate A/D and D/A converter ,understand their types and analyzetheir applications.	L1

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	2		2		2					2	1	
CO2	2	3	3	2		2	2	1					2		1
CO3	2	3	3	2									1	2	
CO4	1			2			3						1		
CO5	2	3	3	2		2		2							2
Avg	1.8	2.4	2.4	2		1.2	1	1					1.2	0.6	0.6
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC202	ELECTROMAGNETIC FIELDS	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To Gain basic knowledge of static electric and magnetic field principles and related laws governing Them
2	To understand the coupling between electric and magnetic fields through Faraday's law, displacement current and Maxwell's equations
3	To derive wave equations for Electromagnetic wave propagation in free space and media

Unit I	STATIC ELECTRIC FIELDS	9	0	0	9

Coulomb's Law– Definition of Electric Field Intensity – Electric Field due to discrete charges, continuous charge distribution, charges distributed uniformly on an infinite and finite line – Electric Field on the axis of a uniformly charged circular disc. Electric Scalar Potential – Relationship between potential and electric field - Potential due to infinite uniformly charged line - Electric Flux Density – Gauss Law

Unit II	STATIC MAGNETIC FIELD	9	0	0	9

The Biot- Savart Law – Magnetic Field intensity due to a finite and infinite wire carrying a current I – Magneticfield intensity on the axis of a circular and rectangular loop carrying a current I – Ampere's circuital law and simple applications. Magnetic flux density – The Lorentz force equation for a moving charge and applications – Force on awire carrying a current I placed in a magnetic field – Magnetic Vector Potential.

Unit III	SEQUENTIAL CIRCUITS	9	0	0	9

Nature of dielectric materials- Definition of Capacitance – Capacitance of various geometries– Electrostatic energy and energy density – Boundary conditions for electric fields – point form of ohm's law – continuityequation for current. Definition of Inductance – Inductance of loops and solenoids – Definition of mutual inductance – simple examples. Energy density in magnetic fields – magnetic boundary conditions

Unit IV	TIME VARYING FIELDS AND MAXWELL EQUATIONS	9	0	0	9

Faraday's law – Maxwell's Second Equation in integral form from Faraday's Law – Equation expressed in point form. Displacement current – Ampere's circuital law in integral form – Modified form of Ampere's circuital law as Maxwell's first equation in integral form – Equation expressed in point form. Maxwell's fourequations in integral form and differential form. Poynting Vector and the flow of power – Instantaneous Average and Complex Poynting Vector.

Unit V	ELECTROMAGNETIC WAVES	9	0	0	9

Derivation of wave equation – uniform plane waves –plane waves in free space and in a homogenous material-Wave equation for a conducting medium – Plane waves in lossy dielectrics – Propagation in goodconductors – Skin effect-Linear, Elliptical and circular polarization – Reflection of Plane Wave from a conductor – normal incidence - Brewster angle.

Total(L+T) =45 Periods

Text Books:

1	William H.Hayt& John Buck : "Engineering Electromagnetics" Tata McGraw-Hill 2006.
2	Joseph Edminister, Schaum's Outline of Electromagnetics, Tata McGraw Hill, 2013

Reference Books:

1	D.K. Cheng, "Field and Wave Electro Magnetics", Pearson (India), 2nd Edition, 1989.
2	Ramo, Whinnery and Van Duzer: "Fields and Waves in Communications Electronics" 3rd edition John Wiley 2003
3	Mathew.N.O.Sadiku, "Elements of Electromagnetics", Oxford University Press, 6th Edition,2015.
4	K.A. Gangadar and P.M. Ramanathan, "Field Theory" 15th Ed., Khanna Publications 2002.
E-References:	
1.	https://archive.nptel.ac.in/courses/108/106/108106073/
2.	https://nptel.ac.in/courses/115101005
3.	https://onlinecourses.nptel.ac.in/noc21_ee83/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Basic knowledge of static electric field principles and related laws	L2
CO2	Basic knowledge of static magnetic field principles and related laws	L2
CO3	Understand the EM wave propagation in a medium and throughboundaries	L3
CO4	Understand Maxwells equations and apply to solve electromagneticproblem	L5
CO5	Understand principles of propagation of uniform plane waves.	L4

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	2									1	1	1
CO2	1	1	2	2									1	1	1
CO3	2	2	2	2							2		1	2	1
CO4	2	3	3	2							2		2	2	2
CO5	2	2	2	2							2		2	2	2
Avg	1.6	1.8	2.2	2							1.2		1.4	1.6	1.4
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC203	SIGNALS AND SYSTEMS		Semester			II
PREREQUISITES		Category	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	To introduce basics of signals and system.
2	To understand and perform Fourier analysis on continuous and discrete time signal and sampling theorem.
3	To introduce Laplace and Z transform in analysing signals and system

Unit I	INTRODUCTION TO SIGNALS AND SYSTEM	9	0	0	9

Classification of Signals: Even and Odd Signal - Energy and power signals - Continuous time (CT) and Discrete time (DT) signals - Continuous and Discrete amplitude signal - System properties and representation: linearity - Time-invariance – Causality – Stability - Realizability. - Linear Time-Invariant(LTI) systems: Impulse response and step response Convolution – Correlation - System representation through differential equations and difference equations.

Unit II	FOURIER ANALYSIS OF CONTINUOUS TIME SIGNAL	9	0	0	9

Continuous Time Fourier Series (CTFS) - Properties of CTFS - Continuous Time Fourier Transform (CTFT) – CTFT of CT periodic signals - Properties of CTFT - Frequency response of systems characterizedby differential equations..

Unit III	LAPLACE TRANSFORM AND CONTINUOUS-TIME LTI SYSTEMS	9	0	0	9

Laplace Transform - Laplace Transforms of some Common Signals - Region of Convergence -Properties of Laplace Transform- Inverse Laplace Transform - System Function - The Unilateral Laplace Transform - Solving differential equation of CT system.

Unit IV	SAMPLING THEOREM AND Z-TRANSFORMS	9	0	0	9

Representation of continuous time signals by its sample - Sampling theorem – Nyquist rate of sampling –Effects of under sampling (aliasing) – Sampling techniques - Data Reconstruction - Sampling of band pass signals - Z-transform - Relationship between z-transform and Fourier transform - Z-transform for discrete timesignals - Region of Convergence – Properties of ROC – Properties of Z-transform - Poles and Zeros - Inverse Z-transform .

Unit V	FOURIER ANALYSIS OF DISCRETE TIME SIGNALS	9	0	0	9

Discrete Time Fourier Series (DTFS) - Properties of CTFS – Discrete Time Fourier Transform (DTFT) – Properties of CTFT - Frequency Response of Discrete Time LTI Systems - Discrete Fourier Transform (DFT) - Realization structures – Direct form I - Direct form – II - Cascade and parallel forms.

Total(L+T) =45 Periods

Text Books:

1	A.Anand Kumar, ” Signals and Systems” , 3rd Edition, PHI, 2013.
2	B.P. Lathi, "Principles of Signal Processing and Linear Systems", Oxford University Press, 2009.

Reference Books:

1	Alan V Oppenheim, Alan S Willsky and S Hamid Nawab, “Signals and Systems”, 2nd edition, PHI Learning Private Limited, New Delhi, 2010
2	Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited,1998.

3	Hsu.H.P, RakeshRanjan "Signals and Systems",2nd Edition Schaum's Outlines, Tata McGraw Hill,2010.
4	Krishnaveni.V, Rajeswari.A, "Signals and Systems", 1st Edition, Wiley India Pvt.. Ltd, 2012.
E-References:	
1.	https://www.youtube.com/watch?v=4GewDCPU5SQ&list=PLy3nfyfK6Yw6bQ-QXJdFrhzd37mgZzk0r
2.	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
3.	http://nptel.ac.in/courses/117104074/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand and Analyse different types of signals and systems.	L2, L4
CO2	Represent continuous and discrete systems in time and frequency domainusing different transforms.	L2
CO3	Able to perform Fourier analysis of signals.	L4
CO4	Sample and reconstruct a signal.	L2
CO5	Realize various structures for discrete time systems	L4

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	3	-							2	2	2
CO2	3	3	2	3	3	2							2	2	2
CO3	3	2	2	3	3	2							2	2	2
CO4	3	2	1	3	3	2							2	2	2
CO5	3	2	2	3	3	-							2	2	2
Avg	3	2.2	1.8	3	3	1.2							2	2	2
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC204	ANALOG CIRCUITS LABORATORY	Semester			II
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives	
1	To understand the analysis and design of LC and RC oscillators, amplifiers and multivibrators.
2	To apply operational amplifiers in Linear and Non linear Applications.
3	To use simulation tools for circuit design.
EXPERIMENTS:	
1	Design of RC Phase shift oscillator and Wein Bridge oscillator.
2	Design of Hartley and Colpitts oscillator.
3	Design of Tuned Class C Amplifier.
4	Design of Astable, Monostable and Bistable multivibrators using BJT.
5	Simulation of Astable, Monostable and Bistable multivibrators.
6	Design of basic Circuits using Op-amp 741.
7	Active Low pass, High pass and Band pass filter.
8	Astable, Monostable multivibrators using Op-Amp.
9	Phase shift and Wien bridge oscillator using op-amp.
10	A stable and Monostable multivibrators using NE555 Timer.
	Total(L+T) =45 Periods

Reference	
1.	Analog Electronic circuits Laboratory Manual.
2.	B.Sasikala,S.PoornachandraRao,"Hand book of experiments in Electronics and Communication Engineering",Vikas Publishing,2007.
E-References:	
1.	http://www.srmuniv.ac.in/sites/default/files/2017/15EI205L-manual-full.pdf
2.	http://www.gopalancolleges.com/gcem/course-material/ece/manuals/sem-lll/analog-electronics-laboratory-manual-10ESL37.pdf
3.	https://www.slideshare.net/vampec/ec-ii-lab-manual

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Design oscillators, multivibrators and power amplifiers for the variety ofengineering applications.	L4
CO2	Design Filters Using op amp and perform experiment on frequencyresponse.	L4
CO3	Design and simulate multivibrators using Simulation Tool.	L3
CO4	Design Oscillators and multivibrators using operational amplifiers	L3
CO5	Understand the concept of high voltage regulators	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	3	3							1	1	2	1	
CO2	2	3	3	3							1	1		1	
CO3	2	2			3										2
CO4	2	2		3	3								2		
CO5	2		2	2	3						1	1		2	
Avg	2	2	1.6	2.2	1.8						0.6	0.6	0.8	0.8	0.4
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC301	ANALOG COMMUNICATION	Semester			III
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Familiarize the concepts of various analog modulation and demodulation techniques
2	To understand the sources of noise and its effects in Communication systems and to analyze the
3	To study the limits set by Information Theory.

Unit I	AMPLITUDE MODULATION	9	0	0	9

Introduction to communication systems – Need for modulation – Generation and demodulation of AM, DSB-SC, SSB-SC - VSB signals - Filtering of sidebands - Comparison of amplitude modulation systems - Frequency translation - Frequency division multiplexing - AM Superhetrodyne receiver.

Unit II	ANGLE MODULATION	9	0	0	9

Angle modulation: Phase and Frequency modulation - Narrowband and Wideband FM - Transmission bandwidth of FM signals - Generation of FM signal – Direct FM – Indirect FM - Demodulation of FM signals - FM stereo multiplexing - PLL - Nonlinear model - FM Superhetrodyne receiver.

Unit III	NOISE PERFORMANCE OF DSB, SSB RECEIVERS	9	0	0	9

Noise : Types of Noise - Noise figure - Noise temperature - Noise Equivalent Bandwidth – Noise in cascaded systems - Representation of Narrowband Noise in terms of In-phase and Quadrature components - Receiver Model - Noise in DSB-SC Receiver - Noise in SSB Receiver.

Unit IV	NOISE PERFORMANCE OF AM AND FM RECEIVERS	9	0	0	9

Noise in AM receivers : Threshold effect - Noise in FM receivers: Capture effect - FM threshold effect - FM threshold reduction - Pre-emphasis and De-emphasis in FM – Comparing the performance of AM and FM.

Unit V	INFORMATION THEORY	9	0	0	9

Uncertainty - Information and entropy - Rate of information - Joint Entropy and Conditional Entropy - Mutual information - Discrete memory less channel - Channel Capacity - Shannon's Theorem - Continuous Channel - Shannon - Hartley Theorem - BW and S/N Trade-off - Huffman and Shannon - Fano codes.

Total(L+T) =45 Periods

Text Books:

1	Simon Haykin, Communication Systems, International Student Version, 5th Edition John Wiley & sons, NY, 2010.
2	Dr .Sanjay Sharma," Communication Systems(Analog and Digital),S.K.Kataria&Sons,6th Reprint,2013.

Reference Books:

1	Taub and Schilling, Principles of communication systems, TMH, New Delhi, 2008.
2	Roddy and Coolen, Electronic communication, PHI, New Delhi, 4th Edition, 2003.
3	R.P. Singh &S.D.Spare, "Communication Systems, Analog&Digital",TataMcGraw Hill, 1995.

4	Anokhsingh, Principles of Communication Engineering, S. Chand & Company Ltd. 2006.
E-References:	
1.	https://www.telecommunications-tutorials.com/
2.	http://www.nptelvideos.in/2012/11/communication-engineering.html
3.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Gain knowledge on the principles of AM and FM communication systems.	L2
CO2	Ability to design AM and FM receiver.	L2
CO3	The exposure to the sources of noise and its effects in Communication systems.	L3
CO4	Ability to analyze the performance of receiver in the presence of noise.	L3
CO5	Ability to measure the capacity of a channel based on the information theory.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	3	3	3	-							2	2	2
CO2	3	3	2	3	3	2							2	2	2
CO3	3	2	2	3	3	2							2	2	2
CO4	3	2	1	3	3	2							2	2	2
CO5	3	2	2	3	3	-							2	2	2
Avg	3	2.2	1.8	3	3	1.2							2	2	2
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC302	CONTROL SYSTEMS	Semester			III
PREREQUISITES	**Category**	**PC**	**Credit**		**3**
Laplace Transform, Partial Differential Equation	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To introduce the components and their representation of control systems.
2	To learn various methods for analyzing the time response, frequency response and stabilityof the systems.
3	To introduce various methods for the state variable analysis.

Unit I	**MATHEMATICAL MODELS OF PHYSICAL SYSTEMS**	**9**	**0**	**0**	**9**

Basic Elements of Control System - Differential equations of physical systems – Open loop and Closed loop systems - Transfer function - Modelling of Electrical systems - Translational and rotational mechanical systems – Analogy - Block diagram reduction Techniques - Signal flow graph – Mason' Gain Formula.

Unit II	**TIME RESPONSE ANALYSIS**	**9**	**0**	**0**	**9**

Standard test signals - Time response analysis - Impulse and Step Response analysis of First and second order systems – Time domain specifications - P, PI, PD and PID controllers - Steady state errors and error constants - Generalized error co-efficient.

Unit III	**FREQUENCY RESPONSE ANALYSIS**	**9**	**0**	**0**	**9**

Sinusoidal TF and frequency Response - Frequency Domain specifications for second order system - Frequency response plots: Bode Plot - Polar Plot –Linear system design : Types of compensators - Lead, Lag and Lead Lag Compensators .

Unit IV	**STABILITY ANALYSIS**	**9**	**0**	**0**	**9**

Stability - Routh-Hurwitz Criterion - Nyquist Stability Criterion - Relative Stability - Root Locus Technique - Construction of Root Locus - Stability, Dominant Poles - Application of Root Locus.

Unit V	**STATE VARIABLE ANALYSIS**	**9**	**0**	**0**	**9**

Concept of state , state variable and state model - State space representation of linear Continuous and discrete Time systems – solutions of State equations – Transfer function from State Variable Representation – Concepts of Controllability and Observability

Total(L+T) =45 Periods

Text Books:

1	I.J Nagrath and M. Gopal, "Control System Engineering", 5th Edition, New Age International Edition, 2018.
2	A.Nagoor kani, "Control Systems" 2nd Edition, RBA publications, 2009

Reference Books:

1	Norman S Nise,"Control Systems Engineering',Seventh edition,Wiley Publications, 2015
2	Benjamin.C.Kuo, Automatic Control Systems, 7thEdition, PHI, 2009.
3	K.Ogata, "Modern Control Engineering", PHI, 5th Edition, 2012.
4	A.Anand Kumar, "Control Systems", Prentice Hall of India, 2012

E-References:	
1.	https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x
2.	https://onlinecourses.nptel.ac.in/noc17_ee12
3.	https://onlinecourses.nptel.ac.in/noc22_ee31/preview

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Frame the transfer function of different physical systems	L2
CO2	Analyse the time domain specification and calculate the steady state error	L3
CO3	Illustrate the frequency response characteristics of open loop and closed loop system response.	L3
CO4	Analyse the stability of the system using Routh and root locus techniques.	L4
CO5	Test the controllability and observability of a physical system	L3

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	1								3		2
CO2	3	1	1	2	1								2		2
CO3	3	1	1	1	1								2		1
CO4	3	1	1	1	1								3	1	2
CO5	2	1	1	1	1								2		1
Avg	2.8	1.2	1.2	1.4	1								2.4	0.2	1.6
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC303	TRANSMISSION LINES AND WAVEGUIDES	Semester			III
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To introduce the various types of transmission lines and to discuss the losses associated.
2	To compute various parameters for loaded transmission lines using Smith chart and acquire knowledge of stub matching in Transmission Lines
3	To impart knowledge on guided waves, rectangular and circular waveguides and waveguide resonators

Unit I	TRANSMISSION LINE THEORY	9	0	0	9

Introduction to Different types of transmission lines – Definition of Characteristic impedance & Propagation Constant – General Solution of the transmission line – physical significance of the equation and the infinite line – Input & Transfer impedance-open and short circuited lines -wavelength and velocity of propagation - Waveform distortion – distortion less transmission line –Loading and its types- Reflection on a line not terminated by Zo – Reflection coefficient –Reflection factor and reflection loss

Unit II	THE LINE AT RADIO FREQUENCIES	9	0	0	9

Voltages and currents on the dissipation less lines – Input impedance of the dissipation less line –parameters of open wire line and co-axial line at high frequencies- Input impedance of open and shortcircuited line – Reflection losses - Standing waves and standing wave ratio on a line – λ/8 line – λ/4 line and λ/2 line- The Smith Chart – Applications of the Smith Chart -Solutions of problems using Smith chart – single stub matching.

Unit III	GUIDED WAVES	9	0	0	9

Waves between parallel planes of perfect conductors – Transverse electric waves - transverse magnetic waves – characteristics of TE and TM Waves – Transverse Electromagnetic waves, properties of TEM wave – Velocities of propagation – Wave impedances TEM waves in waveguides – Dominant mode in rectangular waveguide –Wave impedances – Excitation of modes.

Unit IV	RECTANGULAR WAVEGUIDES	9	0	0	9

Transverse Magnetic Waves in Rectangular Wave guides – Transverse Electric Waves in Rectangular Waveguides – characteristic of TE and TM Waves – Cutoff wavelength and phase velocity – Impossibility of

Unit V	CIRCULAR WAVE GUIDES AND RESONATORS	9	0	0	9

Bessel functions – Solution of field equations in cylindrical co-ordinates – TM and TE waves in circular guides – wave impedances– Dominant mode in circular waveguide – excitation of modes – Microwave cavities, Rectangular cavity resonators, circular cavity resonator

Total(L+T) =45 Periods

Text Books:

1	J.D.Ryder "Networks, Lines and Fields", PHI, New Delhi, 2006.
2	E.C. Jordan and K.G.Balmain "Electro Magnetic Waves and Radiating System, PHI, New Delhi, 2010.

Reference Books:

1	Umesh Sinha "Tranmission Lines & Networks" SathyaPrakashan publication, 2002
2	Annapurna Das and SisirK.Das: Microwave Engineering – TMH, 2000

3	David K.Cheng, Field and Waves in Electromagnetism, Pearson Education, 1989.
E-References:	
1.	https://nptel.ac.in/courses/117101056
2.	https://www.youtube.com/watch?v=0OwmYAljz4A&list=PL0925FD10648D664E
3.	https://link.springer.com/chapter/10.1007/978-1-4615-6459-1_28

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Ability to discuss the propagation of signals through transmission lines.	L3
CO2	Calculate reflection coefficients, standing wave ratio and power of transmission lines	L4
CO3	Ability to compute various parameters for loaded transmission lines using Smith chart and acquire knowledge of stub matching in Transmission Lines	L5
CO4	Ability to explain radio propagation in guided systems	L3
CO5	Ability to utilize cavity resonators	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1		2	3	2							2		1	2	1
CO2		2	3	2							2		1	2	2
CO3		1	2	2							2		2	1	2
CO4		2	2	3							2		2	2	2
CO5		2	2	3									2	2	1
Avg		1.8	2.4	2.4							1.6		1.6	1.7	1.6
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC304	MICROPROCESSORS AND MICROCONTROLLERS	Semester			III
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To familiarise with 8086 and 8051 architectures.
2	To interface 8086 microprocessor and 8051 microcontrollers with peripherals by programming.
3	To gain basic knowledge of PIC microcontrollers.

Unit I	8086 MICROPROCESSOR ARCHITECTURE	9	0	0	9

Overview of Microcomputer systems-8086 Architecture – Pin Assignments – Internal Architecture – Addressing modes-Instruction Formats- Directives and Operators-Assembly process.

Unit II	PROGRAMMING AND INTERFACING OF 8086	9	0	0	9

Fundamental I/O considerations- Programmed I/O- Interrupt I/O- Basic 8086 Configurations- Minimum Mode-Maximum Mode-System Bus timing- I/O interfaces - Peripheral Interfacing using 8255 PPI - 8279 Keyboard/Display controller

Unit III	8051 ARCHITECTURE	9	0	0	9

8051 architecture - Registers in 8051 - Pin description - 8051 parallel I/O ports - memory organization.Instruction set — Addressing modes

Unit IV	PROGRAMMING AND INTERFACING OF 8051	9	0	0	9

Assembly language programming.8051Timers - Serial Port Programming - Interrupts Programming - LCD and Keyboard Interfacing - ADC, DAC Interfacing - External Memory Interface - RTC Interfacing - Motor Control.

Unit V	PIC MICROCONTROLLERS	9	0	0	9

Main characteristics of PIC microcontrollers – PIC microcontroller families-Memory-Program Memory – RAM Data Memory - EEPROM Data Memory - Instruction set and timers in PIC

Total(L+T) =45 Periods

Text Books:

1	Yu-Cheng Liu, Glenn A. Gibson," Microcomputer Systems, The 8086/8088 Family", Pearson, 2e, 2019.
2	Muhammad Ali Mazidi, Janice GillispieMazidi, RolinD.McKinlay, "The 8051 Microcontroller and Embedded Systems using Assembly and C", 2e, 2022.

Reference Books:

1	Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson education, 2011.
2	Martin Bates ,"PIC Microcontrollers-An Introduction to Microelectronics", 3e, Elsevier,2011.
3	Mathur Sunil,"Microprocessor 8086 : Architecture, Programming and Interfacing",PHI Learning Pvt. Ltd.,2011.
4	Salvador PinillosGimenez,"8051 MicrocontrollersFundamental Concepts, Hardware, Software and Applications in Electronics", Springer,2019.

E-References:	
1.	Ashraf Almadhoun,"A Detailed Look Into PIC Microcontroller and Its Architecture",Amazon,2020.
2.	https://nptel.ac.in/courses/108105102

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Describe and analyse the architecture of 8086 microprocessor and 8051 architectures.	L1,L4
CO2	Develop assembly language programs and Interface peripherals with 8086.	L6
CO3	Develop assembly language programs and Interface peripherals with 8051.	L6
CO4	Determine application specific circuit for real-time applications.	L3
CO5	Associate appropriate PIC microcontroller for a given application.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2									2		1		
CO2	2	2	2	2									2	2	
CO3	2	2	2	2									2	2	
CO4	2	2	2	2									2	2	2
CO5	2	2		2									2	2	
Avg	**2**	**2**	**1.2**	**1.6**							**0.4**		**1.8**	**1.6**	**0.4**
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC305	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	Semester			III
PREREQUISITES		**Category**	**PC**	**Credit**	**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives	
1	To introduce students with the architecture and operation of 8086 microprocessor and 8051 microcontroller.
2	To familiarize the students with the programming and interfacing of 8086 microprocessor and 8051 microcontroller.
3	To provide strong foundation for designing real world applications using 8086 microprocessor and 8051 microcontroller.
EXPERIMENTS:	
8086 Programs	
1	Kit Familiarization.
2	Basic Arithmetic and Logic operations.
3	Square, Square root and Cube Program.
4	Code conversion and Matrix operations.
5	String manipulation operations and Sorting and Searching.
6	Peripheral Interfacing of keyboard and display.
7	Traffic light Control.
8	Serial and Parallel Communication.
9	Programs for Digital clock and Stop watch.
10	Stepper Motor Control.
8051 Programs	
11	Basic arithmetic and Logical operations.
12	Find Square and Cube, 2‘s complement of a number.
13	Programs on different addressing modes.
14	A/D and D/A interfacing.
15	Waveform generation using 8051.
	Total(L+T) =45 Periods

Reference Books:	
1	“Microprocessor and Microcontrollers Lab Manual” prepared by ECE Department.

2	https://www.studocu.com/in/document/anna-university/microprocessor-and-microcontroller/microprocessor-microcontroller-labaratory-manual-pdf/17250102

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Perform basic operations in 8086 microprocessor and 8051 microcontroller.	L2
CO2	Interface peripherals with 8086 microprocessor.	L3
CO3	Generate waveforms using Microcontroller.	L3
CO4	Develop assembly language programs for various applications using 8051 microcontroller	L6
CO5	Interface peripherals with 8051 microcontroller.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3											2	2	
CO2	2	3		2	2								2	3	
CO3	2	3		2	2								2	2	
CO4	2	3		2	2								2	3	2
CO5	2	3		2	2								2	2	
Avg	**2**	**3**		**1.6**	**1.6**								**2**	**2.4**	**0.4**
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC401	DIGITAL COMMUNICATION	Semester			IV
PREREQUISITES	**Category**	**PC**	**Credit**		**3**
Analog Communication	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	Understand the building blocks of digital communication system and to prepare mathematical background for communication signal analysis .
2	Express pass-band data transmission and comparison of Digital modulation systems.
3	Analyze the error performance of a digital communication system in the presence of noise and other interferences.Understand the concept of spread spectrum communication system.

Unit I	**DETECTION AND ESTIMATION & SAMPLING PROCESS**	**9**	**0**	**0**	**9**

Model of Digital Communication System - Gram-Schmidt orthogonalization procedure – Geometric interpretation of signals – Detection of known signals in noise - Probability of error - Correlation receiver - Matched filter receiver – Detection of signals with unknown phase in noise – Estimation:concepts and criteria Sampling process:proof– PAM - Other forms of pulse modulation –TDM - Waveform coding techniques: PCM - DPCM - Delta modulation – Adaptive Delta Modulation

Unit II	**BASEBAND TRANSMISSION OF DIGITAL SIGNALS**	**9**	**0**	**0**	**9**

Discrete PAM signals - Inter Symbol Interference - Nyquist's criterion for Distortion less Base band Binary Transmission - Correlative level coding - Duo binary and modified duo binary signalling – Eye patterns – Baseband M-ary PAM Systems – Adaptive Equalization for data transmission.

Unit III	**PASSBAND TRANSMISSION OF DIGITAL SIGNALS**	**9**	**0**	**0**	**9**

Digital Modulation Formats - Coherent Binary Modulation Techniques: Generation – Detection - Signal space diagram - Bit error probability - Power spectra and waveforms of BPSK, BFSK, QPSK and MSK schemes – Non Coherent Binary Modulation Techniques: BFSK, Differential phase shift keying – Comparison binary and quaternary modulation techniques – Introduction to M-ary Modulation techniques – Synchronization: Carrier and symbol synchronization - Applications

Unit IV	**ERROR CONTROL CODING**	**9**	**0**	**0**	**9**

Rationale for coding and types of codes - Discrete memory less channels – Linear block codes - Cyclic codes - Cyclic redundancy check codes - Convolutional codes – Maximum likelihood decoding of convolutional codes- Viterbi Algorithm - Trellis coded Modulation - Maximum length and Gold codes.

Unit V	**SPREAD SPECTRUM MODULATION AND MULTIPLE ACCESS TECHNIQUES**	**9**	**0**	**0**	**9**

Pseudo-Noise sequences – A notion of spread spectrum – Direct sequence spread spectrum with coherent binary phase shift keying – Signal space Dimensionality and processing gain –Probability of error – Frequency Hop Spread Spectrum (FHSS)- Applications --Multiple Access Techniques: TDMA,FDMA,CDMA and SDMA

Total(L+T) =45 Periods

Text Books:

1	Simon Haykins, "Digital Communications" John Wiley, 2017.
2	Theodore S.Rappaport , "Wireless Communications:Principles and Practice", 2nd Edition.", Pearson,2012.

Reference Books:

1	Taub& Schilling, "Principles of Digital Communication", 28th reprint , Tata McGraw-Hill, 2014.

2	R.N.Mutagi,"Digital Communication", 2nd Edition, Oxford University Press, 2013
3	Dennis Roddy, John Coolen,"Electronic Communications", 10th impression, Pearson Prentice Hall, 2013.
4	John G.Proakis, "Digital Communication", 3rd Edition, Tata McGraw-Hill, 1995.
E-References:	
1.	http://www.nptelvideos.in/2012/11/communication-engineering.html
2.	https://www.tutorialspoint.com/analog_communication/analog_communication_introduction.htm
3.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-973-communication-system-design-spring-2006/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Analyze the sampling process and the performance of a baseband and pass band digital communication system in terms of error rate	L2
CO2	Able to analyse the system using eye patterns	L3
CO3	Select the modulation schemes for particular applications .	L3
CO4	Perform the time and frequency domain analysis of the signals in a digital communication system and design error free communication.	L4
CO5	Understand the concept of secured communication and multiple access techniques	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	1								2		2
CO2	2	1	1	2	1								1		2
CO3	1	1	1	1	1								1		1
CO4	2	1	1	1	1								2	2	2
CO5	2	1	1	1	1								2		1
Avg	1.8	1.2	1.2	1.4	1								1.6	0.4	1.6
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22EC402	DIGITAL SIGNAL PROCESSING	Semester			IV
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To analyse the Discrete Fourier Transform, Fast Fourier Transform algorithms.
2	To design and realize IIR, FIR filters and to understand finite word length effects on digital filters.
3	Gain knowledge of DSP architecture, Programming, and concepts of Multi rate signal processing.

Unit I	DISCRETE FOURIER TRANSFORM	9	0	0	9

Introduction to DFT–Properties of DFT-Circular convolution -FFT algorithms–Radix-2 FFT algorithms Decimation in Time and Decimation in Frequency algorithms.

Unit II	INFINITE IMPULSE RESPONSE FILTER DESIGN	9	0	0	9

Characteristics of Analog Butterworth filter-Chebyshev filter-Low pass filter, High pass filter, Band pass filter and Band stop filter-Transformation of analog filters in to equivalent digital filters using bilinear transformation method -Realization structure for IIR filters-Direct form-Cascade form-Parallel form.

Unit III	FINITE IMPULSE RESPONSE FILTER DESIGN	9	0	0	9

Linear phase response of FIR filter - FIR design using window method: Rectangular, Hamming, Hanning and Blackmann Windows - Park-McClellan's method - Realization structures for FIR filters - Linear phase structures and Direct form structure-Comparison of FIR and IIR filters

Unit IV	FINITE WORD LENGTH EFFECTS	9	0	0	9

Representation of numbers-Quantization by truncation and rounding– Derivation for quantization noise power–co-efficient quantization error – Product quantization error – Round off noise power - Limit cycle oscillations due to product round off and over flow errors –scaling to prevent overflow.

Unit V	DSP APPLICATION SAND DIGITALSIGNAL PROCESSOR	9	0	0	9

Introduction to Multi Rate signal processing: Decimation, Interpolation-Introduction to DSPTMS320C54X processor: Architecture- Instruction set-Addressing modes

Total(L+T) =45 Periods

Text Books:

1	S.K.Mitra, "Digital Signal Processing, A Computer Based approach",4thEdition,McGraw-Hill,2010.
2	John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", 4thEdition,PearsonEducation,2009.

Reference Books:

1	Emmanuel C. I feacher, Barry W.Jervis,"Digital Signal Processing :A Practical Approach ",2ndEdition, Pearson Education, 2004.
2	A.V. Oppenheim, R.W.Schaferand J.R. Buck,"Discrete-TimeSignalProcessing",3rdEditionPrenticeHall,
3	L.R.Rabinerand B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.

4	5.J.R.Johnson, “Introduction to Digital Signal Processing”, Prentice Hall,1992.
E-References:	
1.	https://www.coursera.org/learn/dsp
2.	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/
3.	www.nptelvideos.in/2012/12/digital-signal-processing.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Analyse the need for Discrete Fourier Transform, Fast Fourier Transform algorithms in digital signals & systems.	L4
CO2	Design and realize IIR filters	L3
CO3	Design and realize FIR filters	L3
CO4	Analyze finite Word length effect on filters.	L4
CO5	Apply the concepts of Multi rate signal processing and Gain the knowledge on DSP architecture and programming	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	1	1								1	1	1
CO2	3	2	2	2	1		1						1	1	1
CO3	3	2	2	2	1		1						1	1	1
CO4	3	2	2	2	1		1						1	1	1
CO5	1	1	1	1	1								2	2	1
Avg	2	2	1.6	1.6	1		0.6						1.2	1.2	1
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTEC403	EMBEDDED SYSTEMS	Semester			IV
PREREQUISITES	**Category**	**PC**	**Credit**		**3**
Microcontrollers	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To impart knowledge on embedded system architecture and embedded development strategies.
2	To understand the bus communication in processors and peripheral interfacing.
3	To understand basics of Real Time Operating System.

Unit I	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9**	**0**	**0**	**9**

Introduction to Embedded Systems –Structural units in Embedded processor , selection of processor and memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

Unit II	**EMBEDDED NETWORKING**	**9**	**0**	**0**	**9**

Embedded Networking: Introduction, I/O Device Ports and Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.

Unit III	**EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT**	**9**	**0**	**0**	**9**

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

Unit IV	**RTOS BASED EMBEDDED SYSTEM DESIGN**	**9**	**0**	**0**	**9**

Introduction to basic concepts of RTOS- Task, process and threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication – shared memory, message passing – Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

Unit V	**EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT**	**9**	**0**	**0**	**9**

RFID Systems – GPS Navigation System – Automotive Application – Smart card System Application-ATM machine – Digital camera.

Total(L+T)=45 Periods

Text Books:

1	Peckol, “Embedded system Design”, Second Edition, John Wiley & Sons,2019
2	Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013

Reference Books:

1	Shibu. K.V, “Introduction to Embedded Systems”, 2e, Mcgraw Hill, 2017.
2	Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, 3e, McGraw Hill, 2017.
3	Tammy Noergaard, Embedded Systems Architecture, 2e, Newnes an Imprint of Elsevier, Massachusetts, 2013.

4	Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007.
E-References:	
1.	https://nptel.ac.in/courses/108102045
2.	https://nptel.ac.in/courses/106105193
3.	https://www.coursera.org/learn/introduction-embedded-systems

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand and analyze Embedded systems	L2
CO2	Know about the bus Communication and Peripheral interfacing	L1
CO3	Know about the embedded product development and modeling	L2
CO4	Acquire knowledge on Real time operating system	L2
CO5	Design and Analyze the real-time applications of embedded-systems	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2		1	2	2								1		
CO2	2		2	2	2								2		2
CO3	2	1	3	3	2				2				2	1	2
CO4	2		3	2	3								1	1	1
CO5	2	2	3	3	3	2	2		2				2	2	2
Avg	2	0.6	2.4	2.4	2.4	0.4	0.4		0.8				1.6	0.8	1.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC404	ANTENNA AND WAVE PROPAGATION	Semester			IV
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the fundamental principles of Antenna theory, and wave propagation with a lucid explanation of the basic concepts and equations.
2	To understand the design and operation of various antenna types.
3	To study the fundamental electromagnetic wave propagation indifferent layers of the atmosphere.

Unit I	RADIATIONFIELDSOFWIRE ANTENNAS	9	0	0	9

Potential functions and electromagnetic field - Potential functions for sinusoidal oscillations - Fields associated with Hertzian dipole - Alternating current element - Power radiated and radiation resistance of current element – Radiation resistance of elementary dipole with linear current distribution-Current distribution on a thin wire antenna-Radiation from half-wave dipole or Effective length-Effective area.

Unit II	ANTENNA ARRAYS	9	0	0	9

Expression for electric field from two and three element arrays- Uniform linear array - Broadside array – Endfire array - Method of pattern multiplication - Binomial array - Use of the method of images for antennas above ground –Folded dipole antenna- Yagi Uda antenna-Log periodic dipole array.

Unit III	LOOP, HELICAL AND REFLECTOR ANTENNA	9	0	0	9

Loop Antennas: small loop and general case - Radiation resistance of loops – Directivity of the circular loop – $\lambda/10$diameter loop – λ/π diameter loop -Helical antenna: Helical geometry – mono filar axial-mode helical antenna –Radiation from a traveling wave on a wire- Rhombic antenna: Analysis & Design of Rhombic antennas–Reflector antennas :Flat sheet reflector-Corner reflector –Paraboloidal reflector-Feed systems.

Unit IV	APERTURE AND LENS ANTENNA	9	0	0	9

Induction and equivalence theorems - Radiation from an elemental area of a plane wave (Huygen's Source) -Radiation from the open end of a coaxial line - Radiation from a rectangular aperture treated as an array of Huygen's sources–Slot antennas-Pattern of slot antennas in flat sheets-Babinet's principle and complementary antennas- Impedances of slot antennas - Method of feeding slot antennas -Field on the axis of an E-Plane sectoral horn -Radiation from circular aperture-Beam Width and Effective area-Dielectric lens and metal plane lens antennas-Lumeberg lens -Spherical waves and Biconical antenna.

Unit V	WAVEP ROPAGATION	9	0	0	9

Sky wave propagation**:** Structure of the ionosphere - Effective dielectric constant of the ionized region - Mechanism of refraction - Refractive index - Critical frequency - Skip distance - Effect of earth's magnetic field - Energy loss in the ionosphere due to collisions-Maximum usable frequency-Fading and Diversity reception-Space wave propagation -Reflection from the ground for vertically and horizontally polarized waves - Reflection characteristics of the earth-Resultant of direct and reflected ray at the receiver -Duct propagation -Ground wave propagation: Attenuation characteristics for ground wave propagation-Calculation of field strength at a distance.

Total(L+T)=45 Periods

Text Books:

1	E.C.Jordan and Balmain, "ElectroMagneticWaves andRadiating Systems",PHI,1968,Reprint2010.
2	John D. Krausand Ronalatory Marhefka,"Antennas", TataMcGraw-HillBookCompany,2010.

Reference Books:	
1	Terman,F.E., “Radio EngineersHandbook”,TataMcGraw-Hill, 1985.
2	ConstantineA.Balanis, "AntennaTheoryAnalysis andDesign”,JohnWiley&Sons,2012.
3	R.E.Collins,'AntennasandRadioPropagation",McGraw-Hill, 1987.
4	Elliot, R.S,“Antennatheoryanddesign”,PHI, NewDelhi,1985.
E-References:	
1.	https://www.youtube.com/watch?v=LF9kebBTWXo&list=PLAULbhIvfai5yvvLIm-oIb89dGNp1BtM6
2.	https://www.youtube.com/watch?v=jA8aTA1Pg4s&list=PLCcWs0lpRgKcOu8LAX7GlZLIAHgyN1oVS
3.	https://link.springer.com/chapter/10.1007/978-1-4615-6459-1_28

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand and derive the behaviour of the antenna and its performance parameters.	L4
CO2	Design and analyze antenna arrays.	L4
CO3	Design and analyze Loop, Helical and Reflector antenna.	L4
CO4	Design and analyze aperture and lens antennas.	L4
CO5	Study radio wave propagation and its effects.	L2

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	1								2	2	1
CO2	3	2	2	2	1		1						1	1	1
CO3	3	2	2	2	1		1						1	1	1
CO4	3	2	2	2	1		1						1	1	1
CO5	3	1	1	1	1								0	0	0
Avg	3	2	1.6	1.6	5		0.6						1	1	0.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC405	DIGITAL SIGNAL PROCESSING LABORATORY	Semester			IV
PREREQUISITES		Category	PC	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives	
1	To implement basic signals operations using a software tool.
2	To design FFT algorithms,
3	To design IIR and FIR filters

EXPERIMENTS:	
1	Generation of Signals
2	Discrete-time convolution
3	Circular convolution of two sequences
4	Sampling and effect of aliasing
5	Spectrum analysis using Discrete Fourier Transform
6	Calculation of FFT of a signal using a) Decimation in time algorithm b) Decimation in frequency algorithm
7	Design of FIR filters using a)Windowing technique b)Frequency sampling method
8	Design of IIR digital filter using Bilinear transformation
9	Design of IIR digital filter using Impulse invariant method
10	Verification of BIBO stability of a system.

Total (45+15) = 60 Periods

References:	
1	Digital Signal Processing Using MATLAB, VinayK.Ingle John G.Proakis,Centage learning,3rd Edition,2012
2	SanjitK. Mitra,"DigitalSignalProcessing",3rd Edition,McGrawHillHigherEducation,2007.

E-References:	
1	https://nptel.ac.in/courses/117102060/ Students focus. com/notes/anna_university/ECE/5SEM/EC6511 %20 %20 DSP %20 Lab/EC %20 6511 %20 DIGITAL %20 SIGNAL %20 PROCESSING %20 LAB %20 MANUAL _2013_ regulation.pdf vlab.co.in/ba_nptel_labs.php?id=1

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Generate and analyze various signal processing algorithms.	L4
CO2	Implement FFT algorithms, Linear/Circular convolution.	L4
CO3	Design FIR filters.	L3
CO4	Design IIR filters.	L3
CO5	Verify and understand system stability.	L4

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	1	3			1		1			1	1	1
CO2	3	3	1	1	3			1		1			1	1	1
CO3	3	3	2	2	3			1		1			1	1	1
CO4	3	3	2	2	3			1		1			1	1	1
CO5	3	3	2	2	3			1		1			1	1	1
Avg	3	3	1.6	1.6	3			1		1			1	1	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC501	VLSI DESIGN	Semester			V
PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	Develop ability to understand the concepts of MOS transistors operations and their AC, DCcharacteristics.
2	To understand the fabrication process of CMOS technology and its layout design rules
3	Digital Design using Verilog HDL and understand CMOS chip design**.**

Unit I	MOS TRANSISTOR THEORY	9	0	0	9

Introduction: NMOS, PMOS Enhancement transistor, Threshold voltage, Body effect – MOS device DCEquation, channel length modulation, Mobility variation, MOS models, small signal AC characteristics -Complementary CMOS inverter - DC characteristics: Noise Margin, Rise time, fall time, power dissipation, transmission gate – stick diagram – Layout diagram.

Unit II	CMOS TECHNOLOGY	9	0	0	9

An overview of Silicon semiconductor technology - Basic CMOS technology: nwell, P well, Twin tub andSOI Process – CMOS process enhancements: Interconnects - circuit elements: Resistors, capacitors, Electrically alterable ROMs, bipolar transistors - Latch up and its prevention techniques

Unit III	DATA PATH SYSTEMS AND ARRAY OF SUBSYSTEMS	9	0	0	9

Datapath Subsystems, Addition/Subtraction, One/Zero Detectors, Comparators, Counters, Boolean Logical Operations, Shifters, Multiplication Array Subsystems, SRAM, DRAM, Read-Only Memory, Serial Access Memories, Content Addressable Memory.

Unit IV	HARDWARE DESCRIPTION LANGUAGE	9	0	0	9

Basic Concepts: VLSI Design flow, modules and ports, switch level modeling, Gate level modeling, Data flowmodeling, Behavioralmodeling. Structural gate level description of decoder, equality detector, comparator, priority encoder, D-ff, half adder, Full adder, Ripple Carry adder.

Unit V	CMOS CHIP DESIGN	9	0	0	9

CMOS chip design options: Full custom ASICs, Standard Cell based ASICs, Gate Array based ASICs Channeled, Channel less and structured GA, Programmable logic structures; Programming of PALs, Programmable Interconnect, ASIC design flow, Need for CMOS testing

Total (45+15) = 60 Periods

Text Books:

1	N. H. E. Weste, D.F. Harris, “CMOS VLSI design”, (4/e), Pearson , 2011
2	Samir Palnitkar: “Verilog HDL” A Guide to Digital Design and Synthesis Second Edition – SecondEdition, 2012.

Reference Books:

1	M.J.S .Smith, - “Application - Specific Integrated Circuits” – Pearson Education, 2009
2	Douglas.A.Puchnell.,Kamran Eshraghian ’Basics VLSI Design and Circuits’ Third edition PrenticeHall India 2011.
3	V.G.Kirankumar, H.R.Nagesh, ”Introduction to VLSI Design”, Pearson Education,2011

4	Wayne Wolf, Modern VLSI Design, Pearson Education 2003
E-References:	
1.	https://freevideolectures.com/Subject/VLSI-and-ASIC-Design
2.	https://www.tutorialspoint.com/vlsi_design/vlsi_design_useful_resources.html
3.	https://nptel.ac.in/courses/117101058/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use analytical methods and circuit analysis models in analysis of CMOScircuits.	L2
CO2	Gain knowledge to understand the CMOS process technology and todesign array of systems.	L3
CO3	Design data path systems.	L3
CO4	Model the digital system using Verilog Hardware Description Language.	L3
CO5	Gain knowledge on chip design using programmable devices.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1		1										1	2	1
CO2			1										1	2	1
CO3	2		3										1	2	1
CO4	1	2	3	2	3								1	2	1
CO5			1										1	2	1
Avg	0.8	0.4	1.8	0.4	0.6								1	2	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC502	OPTICAL AND MICROWAVE ENGINEERING	Semester	V

PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand and gain knowledge about various microwave components.
2	To study the microwave generation and amplification using microwave tubes and solid-statedevices and to understand the concepts of strip lines and MMIC.
3	To understand the different kind of losses, signal distortion in optical wave guides and other signaldegradation factors.

Unit I	MICROWAVE COMPONENTS	9	0	0	9

Hybrid Circuits - Waveguide Tees - Magic Tees (Hybrid Tees) - Hybrid Rings (Rat-Race Circuits) - Waveguide Corners - Bends and Twists - Directional Couplers - Two-Hole Directional Couplers - Reviewof low frequency parameters: Z, Y and ABCD Parameters - Introduction to S parameters - S Matrix of a Directional Coupler - Hybrid Couplers - Circulators and Isolators.

Unit II	SOLID STATE MICROWAVE DEVICES	9	0	0	9

Introduction- Gunn_Effect Diodes - GaAs Diode - Ridely-Watkins - Hilsun (RWH) Theory - Modes of Operation - Microwave Generation and Amplification - Avalanche transit - Time devices – Introduction -Read Diode -IMPATT Diodes - TRAPATT Diodes -BARITT Diodes - Parametric Devices.

Unit III	MICROWAVE TUBES	9	0	0	9

Klystrons - Two cavity Klystron Amplifiers - Reflex Klystrons - Velocity Modulation - Power Output andEfficiency - Electronic Admittance - Helix Traveling - Wave Tubes (TWTs) - Slow-Wave structures - Amplification Process - Convection Current - Axial Electric Field - Wave Modes - Gain Consideration - Magnetron Oscillators - Cylindrical Magnetron - Coaxial Magnetron.

Unit IV	SIGNAL DEGRADATION IN OPTICAL FIBERS	9	0	0	9

Attenuation - Absorption losses - Scattering losses - Bending Losses - Core and Cladding losses - Signal Distortion in Fibers - Intermodal delay - Intramodal dispersion - Factors contributing to dispersion - Group Delay - Material Dispersion - Wave guide Dispersion - Basics of semiconductor physics – LED – Structures- Light source materials - Quantum efficiency and LED power - LASER diodes.

Unit V	FIBER OPTICAL RECEIVERS AND DIGITAL TRANSMISSION SYSTEM	9	0	0	9

Physical principles of photodiodes - PIN photo diode - Avalanche photo diodes - Photodetector noise - SNR-Detector response time - Double Hetero structure photodiodes - structure for InGaAS APDs -Temperature effect on avalanche gain - Fundamental receiver operation - Digital signal transmission - Error sources - Front end amplifier - Digital receiver performance - Receiver sensitivity - Optical Amplifiers – Types - Erbium Doped fiber amplifier..

Total(L+T)=45 Periods

Text Books:

1	Samuel Y.Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson education, 2008.
2	Gerd Keiser, “Optical Fiber Communication” , 3rd& 4th Edition, McGraw –Hill International, 2012

Reference Books:	
1	R.E. Collin, “Foundations for Microwave Engineering”, 2nd Edition, IEEE Press , 2002.
2	David M.Pozar, “Microwave Engineering”, 2nd Edition, John Wiley & Sons, 2003
3	P.A.Rizzi, “Microwave Engineering Passive circuits”, PHI
4	S.C.Gupta, “Textbook on Optical Fiber Communication and its applications”, 2nd Edition, PHI,2012.
E-References:	
1.	https://nptel.ac.in/courses/108101112
2.	http://nptel.ac.in/courses/113104012/
3.	http://nptel.ac.in/courses/115102026/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Explain the active and passive microwave components used in microwavecommunication.	L1
CO2	Have an in-depth knowledge of microwave generation and amplification.	L2
CO3	Calculate the degradation in the signal due to losses and dispersion.	L4
CO4	Explain the various optical sources and optical detectors and their use inthe optical communication system.	L5
CO5	Thorough knowledge about optical transmitter and receiver types anddesign	L3

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		2	2	2							1		1	2	1
CO2		3	2	3							2		1	2	1
CO3		2	2	2									2	1	2
CO4		2	2	2							2		2	1	2
CO5		1	2	2							1		1	2	1
Avg		2	2	2.2							1.2		1.4	1.6	1.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC503	PRINCIPLES OF MANAGEMENT		Semester			V
PREREQUISITES		Category	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

Course Learning Objectives

1	Understand the managerial functions like planning, organizing, staffing, leading and controlling
2	Understand international aspect of management
3	Understand the method of applying principles in various managerial situations.

Unit I	HISTORICAL DEVELOPMENT	9	0	0	9

Definition of Management – Science or Art – Management and Administration – Role of managers - Development of Management Thought – Contribution of Taylor and Fayol – Functions of Management –Organizational and environmental factors – Managing globally – Strategies to international business - Types of Business Organization.

Unit II	PLANNING	9	0	0	9

Nature and Purpose – Steps involved in Planning – Objectives – Setting Objectives – Process of Managing by Objectives – Strategies, Policies and Planning Premises - Barriers to planning Forecasting – Decision-making

Unit III	ORGANISING	9	0	0	9

Nature and Purpose – Formal and informal organization – Organization Chart – Structure and Process Departmentation by difference strategies – Line and Staff authority – Benefits and Limitations – De- Centralization and Delegation of Authority – Staffing – Selection Process - Techniques – HRD – ManagerialEffectiveness – performance appraisal – Managing team conflict.

Unit IV	DIRECTING	9	0	0	9

Scope – Human Factors – Creativity and Innovation – Harmonizing Objectives – Leadership – Types of Leadership Motivation – Hierarchy of needs – Motivation theories – Motivational Techniques – Job Enrichment – Communication – Process of Communication – Barriers and Breakdown – Effective Communication – Electronic media in Communication – Interpersonal Skills.

Unit V	CONTROLLING	9	0	0	9

System and process of Controlling – Requirements for effective control – The Budget as Control Technique –Information Technology in Controlling – Use of computers in handling the information – Productivity – Problems and Management – Control of Overall Performance – Direct and Preventive Control – Reporting – The Global Environment – Globalization and Liberalization – International Management and Global theory ofManagement – Total quality management(TQM) principles.

Total (45+15) = 60 Periods

Text Books:

1	Harold Kooritz& Heinz Weihrich , "Essentials of Management", Tata McGraw-Hill, 2015.
2	Joseph L Massie "Essentials of Management", 4th Edition, Prentice Hall of India, (Pearson), 2003

Reference Books:

1	Tripathy PC and Reddy PN, "Principles of Management", Tata McGraw-Hill, 1999.

2	Decenzo David, Robbin Stephen A, "Personnel and Human Reasons Management", Prentice Hall ofIndia, 1996
3	AF Stomer, Freeman R. E and Daniel R Gilbert," Management,", 6th Edition,Pearson Education,2004
4	Fraidoon Mazda, "Engineering Management", Addison Wesley,2000.
E-References:	
1.	https://www.coursera.org/learn/fundamentals-of-management
2.	https://nptel.ac.in/courses/122108038/
3.	https://alison.com/course/an-introduction-to-the-principles-of-management

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Apply the principles of management for all kinds of people in all kinds oforganization	L2
CO2	Understand the managerial functions like planning, organizing, staffing,leading and controlling	L2
CO3	Gain Basic knowledge on international aspect of management	L2
CO4	Understand basics of Total Quality Management	L2
CO5	Improve interpersonal managerial skills	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1							2	2	2	-	-	2	1	2	2
CO2							2	3	2	-	2	2	1	2	2
CO3							2	2	2	-	-	2	1	2	2
CO4							2	-	2	-	1	2	1	2	2
CO5							2	3	2	3	2	2	1	2	2
Avg							2	2	2	0.6	1	2	1	2	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC504	ELECTRONIC MEASUREMENTS	Semester	V
PREREQUISITES	Category	PC	Credit 3

	L	T	P	TH
Hours/Week	3	0	0	3

Course Learning Objectives

1	To Know the basic measurement concepts, units, standards, various types of meters and errors.
2	Learn to measure unknown value of components using bridges and understand the concept of various signal generator and analyzers.
3	To gain knowledge on Different types transducers and their usage in the Data Acquisitionsystem
4	To emphasize the need for Data display recording and systems

Unit I	BASIC MEASUREMENTS	9	0	0	9

Introduction – Characteristics of measurement systems – Static and Dynamic – Errors in Measurements – Calibration and Standards - DC Ammeters and Voltmeters - AC Ammeters and Voltmeters - Multirange – Ohm meter: series Type, Shunt Type – Electronic Multimeter

Unit II	BRIDGE MEASUREMENT	9	0	0	9

Introduction - DC Bridges and their Applications - Wheatstone Bridge - Kelvin Bridge - AC Bridges and their Applications - Maxwell's Bridge - Hay Bridge - Schering Bridge - Wein Bridge - Wagner ground Connection

Unit III	SIGNAL GENERATOR & ANALYZERS	9	0	0	9

Signal Generators: Sine wave generator, Frequency Synthesized Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators. - Sweep Frequency Generator - Pulse and square wave generator - Function Generators - Signal Analyzers: Wave Analyzers - Harmonic Distortion Analyzers – Spectrum Analyzers.

Unit IV	TRANSDUCER & DATA ACQUISITION SYSTEMS	9	0	0	9

Classification of Transducers – Variable Resistive transducers – Strain gauges, Thermistor, RTD - Variable Inductive transducers - LVDT, RVDT - Variable Capacitive Transducers - Photo electric transducers, Piezo electric transducers – Thermocouples - Thermistors – Smart / intelligent sensors, Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System.

Unit V	DATA DISPLAY RECORDING AND SYSTEMS	9	0	0	9

Dual trace CRO – Digital storage and Analog storage oscilloscope. Analog and Digital Recorders and printers. Virtual Instrumentation - Block diagram and architecture – Applications in various fields. Measurement systems applied to Micro and Nanotechnology.

Total(L+T) =45 Periods

Text Books:

1	Albert D.Helfrick and William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 5th Edition, PHI, 2011.
2	A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2010.

Reference Books:

1	John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", CRC Press. 2014
2	Robert A.Witte, "Electronic Test Instruments, Analog and Digital Measurements", 2nd Edition, Pearson Education, 2004.

3	K. Lal Kishore, “Electronic Measurements and Instrumentations”, Pearson Education, 2005.
4	Deoblin E.O. “Measurement Systems - Application and Design”, McGraw Hill, 4th Edition, 2005
E-References:	
1.	https://nptel.ac.in/courses/108105153
2.	http://bcas.du.ac.in/wp-content/uploads/2020/04/Study-Material-Dr.-Avneesh-Mittal.pdf
3.	http://www.academia.edu/8140873/A_K.Sawhney-

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Discuss about the principles of various measurement techniques and identify its errors	L2
CO2	Have knowledge on designing and to find the unknown elements in the measuring bridges.	L3
CO3	To categorize different instruments used for signal generation and analysis.	L2
CO4	Analyze the transducers and its impact and to understand the function of Data acquisition systems.	L2
CO5	To have knowledge on Data display and recording Systems.	L1

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1		1								3		2
CO2	3		2	2	1								3	1	2
CO3	3	1		1	2								3	1	2
CO4	3		1	2									3		1
CO5	3	2	1		1								3	2	2
Avg	3	1	1	1	1								3	0.8	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC505	VLSI Design and Embedded Systems Laboratory	Semester	V
PREREQUISITES	Category	PC	Credit 3

	L	T	P	TH
Hours/Week	3	0	0	3

Course Learning Objectives

1	Digital system design using Hardware Description Language.
2	To practically train the programming concepts using Verilog HDL and implement in FPGA.
3	Design the Building Blocks of Embedded Systems and simulation tools.

EXPERIMENTS:

1	Design and simulate Combinational circuits using Verilog HDL.
2	Design and simulate Sequential circuits using Verilog HDL.
3	Design Traffic light controller using Verilog HDL.
4	Study of FPGA Board.
5	Implementation of ALU/MAC unit in FPGA.
6	Implementation of Flip-Flops in FPGA.
7	Embedded program for I/O interfacing using PIC controller..
8	Design a stepper motor controller using LCD and keys in PIC controller.
9	Generate 3-phase PWM signals and demonstrate the utility of PWM with high bright LED lights using RL 78.
10	Measure room temperature and display the same in a LCD with keyboard interaction using RL 78
11	Demonstrate the usage of watchdog timers and voltage detection facilities of RL78 in an application.
12	Basic experiments using ARM cortex

Total(P)=30 Periods

Reference:

1	Samir Palnitkar: "Verilog HDL" A Guide to Digital Design and Synthesis Second Edition , 2nd Edition, Pearson Education , 2012.
2	J.Bhaskar, " Verilog HDL Primer" 2nd Edition, 2004.

E-Reference Books:

1	https://www.tutorialspoint.com/vlsi_design/vlsi_design_verilog_introduction.htm

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Model a combinational circuit using Verilog HDL.	L2
CO2	Model sequential circuit using Verilog HDL.	L3
CO3	Import the logic modules into FPGA boards.	L3
CO4	Write, debug and compile embedded processors programs for a given Application.	L6
CO5	Implement interrupt control for a given embedded System.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3											2	2	
CO2	2	3		2	2								2	3	
CO3	2	3		2	2								2	2	
CO4	2	3		2	2								2	3	2
CO5	2	3		2	2								2	2	
Avg	**2**	**3**		**1.6**	**1.6**								**2**	**2.4**	**0.4**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC601	COMPUTER NETWORKS	Semester			VI
PREREQUISITES	Category		Credit		
	Hours/Week	L	T	P	TH

Course Learning Objectives

1	To introduce the basic concept in modern data communication and computer networking.
2	To introduce the students the functions of different layers and in-depth knowledge of data link layer.
3	To make students to get familiarized with different protocols and network layer components.
4	To introduce the basic functions of transport layer and congestion in networks.
5	To understand the concepts of various network Applications and Data security.

Unit I	NETWORK FUNDAMENTALS AND PHYSICAL LAYER	9	0	0	9

Components – networks – Topologies – The OSI reference model - layers and duties. TCP/IP reference model – layers and duties, Physical Layer: Transmission Media – Guided media & unguided media - EIA 232, SONET

Unit II	DATA LINK LAYER	9	0	0	9

Logical link control Functions: - Framing, Flow control, Error control: CRC, LLC protocols -HDLC, P to P- Medium access layer: - Random access, Controlled access, Channelization - Wired LANs: Ethernet IEEE 802.3, IEEE 802.4, and IEEE 802.5. Internetworking, Interconnection issues, Interconnection devices: - Repeaters, Hubs, Routers/switches and Gateways**.**

Unit III	NETWORK LAYER `	9	0	0	9

Switching-Circuit switching, packet switching, message switching. Internet protocols; IPV4, IPV6, ARP, RARP, ICMP, IGMP, VPN. Network Routing Algorithms - Unicast routing protocol: Distance Vector Routing – Link State Routing – Multicast Routing.

Unit IV	TRANSPORT LAYER	9	0	0	9

Transport Services, Elements of Transport protocols, Connection management, – User Datagram Protocol (UDP) – ransmission Control Protocol (TCP) –Congestion Control and Quality of services (QoS) – Integrated Services

Unit V	APPLICATION LAYER	9	0	0	9

Domain Name Space (DNS) – Electronic mail (SMTP, MIME, POP3, IMAP4) - Application protocols: WWW, HTTP, FTP and TELNET, Network management protocol: SNMP.

Total (45+15) = 60 Periods

Text Books:

1	Behrouz A. Foruzan, “Data communication and Networking”, TMH, 4th edition, 2014.
2	James. F. Kurouse & W. Ross, “Computer Networking: A Top down Approach Featuring”, Pearson, 2020.

Reference Books:

1	Larry L.Peterson& Peter S. Davie, “Computer Networks”, Harcourt Asia Pvt. Ltd., Second Edition.
2	Andrew S. Tanenbaum, “Computer Networks”, PHI, Fourth Edition, 2003.

3	An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education
4	Ajit Pal, "Data Communication and Computer Networks", PHI, 2014.
E-References:	
1.	https://nptel.ac.in/courses/106105183
2.	https://www.mbit.edu.in/wp-content/uploads/2020/05/Computer-Networks-5th-Edition.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Explain the basic concept in modern data communication and different level of layers in the protocol	L2
CO2	Analyze the functions and services of data link layer	L4
CO3	Categorize the functions and services of network layer	L2
CO4	Examine the basic functions of transport layer and congestion in networks	L2
CO5	Analyze the concepts of various network applications and data security	L4

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1		1								2		1
CO2	2	1	2		1								2	1	1
CO3	2	1	1										3	1	2
CO4	3	2	1		2								2		2
CO5	2	1	1		1								1	1	1
Avg	2.2	1.2	1.2		1								2	0.6	1.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC602	SATELLITE COMMUNICATION		Semester			VI
PREREQUISITES		**Category**	**PC**	**Credit**		**3**
Digital Communication		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Learning Objectives

1	The goal of the course is to introduce students to the fundamentals of satellite communication
2	To provide them with a sound understanding of how a satellite communication system successfully transfers information from one earth station to another.
3	To expose them to examples of applications and tradeoffs that typically occur in engineering system design, and to ask them to apply the knowledge in design problems.

Unit I	**OVERVIEW OF SATELLITE SYSTEMS, ORBITS AND LAUNCHING METHODS**	**9**	**0**	**0**	**9**

Introduction – Frequency Allocations for Satellite Services – INTELSAT – U.S.Domsats – Polar Orbiting Satellites- Kepler's First Law – Kepler's Second Law – Kepler's Third Law – Definitions of Terms for Earth -orbiting Satellites – Orbital Elements – Apogee and Perigee Heights – Orbital Perturbations - Local Mean Solar Time and Sun - Synchronous Orbits.

Unit II	**GEOSTATIONARY ORBIT & SPACE SEGMENT**	**9**	**0**	**0**	**9**

Introduction – Antenna Look Angels – The Polar Mount Antenna – Limits of Visibility – Near Geostationary Orbits – Earth Eclipse of Satellite – Sun Transit Outage – Launching Orbits - Power Supply – Attitude Control – Station Keeping – Thermal Control – TT&C Subsystem – Transponders - Antenna Subsystem – Morelos and Satmex5 – Anik-Satellites – Advanced Tiros - N Spacecraft.

Unit III	**EARTH SEGMENT & SPACE LINK**	**9**	**0**	**0**	**9**

Receive_Only Home TV Systems – Master Antenna TV System – Community Antenna TV System – Transmit_Receive Earth Stations - Equivalent Isotropic Radiated Power – Transmission Losses : Free-Space Transmission – Feeder Losses – Antenna Misalignment Losses – Fixed Atmospheric and Ionospheric Losses – Link Power Budget Equation – Carrier-to-Noise Ratio – Uplink – Down link - Effects of rain – Combined Uplink and Downlink C/N Ratio – Inter modulation Noise.

Unit IV	**SATELLITE ACCESS**	**9**	**0**	**0**	**9**

Single Access – Preassigned FDMA - Demand-Assigned FDMA - SPADE System - Bandwidth-limited and Power-limited TWT amplifier operation - TDMA -On-board signal Processing for TDMA / FDMA operation - Satellite switched TDMA - Code Division Multiple Access.

Unit V	**DBS & SATELLITE MOBILE AND SPECIALIZED SERVICES**	**9**	**0**	**0**	**9**

Direct Broadcast Satellite (DBS) Television - Orbital Spacing - Power Rating and Number of Transponders -Frequencies and Polarization -Transponder capacity - Bit rates for digital Television -The Home Receiver Outdoor Unit(ODU)-The Home Receiver Indoor Unit(IDU) – HDTV - Satellite Mobile Services – VSATs – GPS –Orbcomm.

Total (45L+0T)= 45 periods

Text Books:

1	Dennis Roddy, Satellite Communications, Tata McGraw-Hill Education Private Limited, fourth edition, 2009
2	Barry George Evans, Satellite communication systems, 3rd Edition, IET Publications 1999

Reference Books:

1	Timothy Pratt – Charles Bostian& Jeremy Allmuti, Satellite Communications, John Willy & Sons (Asia) Pvt. Ltd, second edition 2014
2	Wilbur L. Pritchars Henri G.SuyderHond Robert A.Nelson, Satellite Communication Systems Engineering, Pearson Education Ltd., Second edition 2003..
3	M.Richharia, Satellite Communication Systems (Design Principles), Macmillan Press Ltd. Second Edition 2003.
4	Satellite communication engineering By Michael O. Kolawole, CRC Press, 2002.
E-References:	
1.	http://nptel.ac.in/courses/117105131/
2.	http://nptel.ac.in/courses/106105082/33
3.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-851-satellite-engineering-fall-2003/lecture-notes/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Describe the motion of satellite in the orbit and understand orbital effects in communications system performance.	L2
CO2	Calculate the received carrier power at the input of earth station receiver or satellite transponder.	L3
CO3	Compute the noise power and carrier to noise ratio at the input of earth station or satellite transponder	L3
CO4	Calculate losses and design both up-link and down link	L3
CO5	design domestic satellite system using small earth station	L2

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		2	2	2	1								1	2	1
CO2	2	1	1	2	1								1	2	2
CO3	2	1	1	1	1								1	2	1
CO4	2	1	1	1	1								2	2	1
CO5	1	1	1	1	1								2	1	1
Avg	1.4	1.2	1.2	1.4	1								1.4	1.8	1.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC603	COMMUNICATION SYSTEMS LABORATORY	Semester	VI

PREREQUISITES	Category	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To make the students to understand the basics of analog and digital modulation techniques
2	To deal with the different pulse modulation schemes.
3	To simulate different modulation scheme using suitable tool.

EXPERIMENTS

1.	Generation and detection of AM signal
2.	Generation and detection of FM signal
3.	Pulse Amplitude Modulation
4.	Pulse Width Modulation
5.	Pulse Position Modulation
6.	Sampling and reconstruction of signals
7.	Digital Modulation Techniques: ASK,PSK,FSK,QPSK
8.	Delta and Adaptive Delta modulation
9.	Pulse Code Modulation
10.	Time Division Multiplexing and De multiplexing
11.	Generation of various line codes.
12.	Simulation and performance analysis of analog and digital modulation techniques .

Total (60P)= 60 Periods

Text Books:

1	S.Poorna Chandra, B.Sasikala, “Electronics Laboratory Primer”, S.Chand& Company Ltd, 2010.
2	L.K. Maheshwari, M.M.S. Anand, “Laboratory Manual for Introductory Electronics Experiments”, New age International (P) Limited Publishers, 2010.
3	Simon Haykin S., "Digital Communications Systems", 3rd Edition, John Wiley and Sons, 2013.

Reference Books:

1	Simon Haykins, “Digital Communications” John Wiley, 2017.
2	Taub& Schilling, “Principles of Digital Communication”, 28th reprint , Tata McGraw-Hill, 2014.
3	R.N.Mutagi,”Digital Communication”, 2nd Edition, Oxford University Press, 2013

4	Dennis Roddy, John Coolen,"Electronic Communications", 10th impression, Pearson Prentice Hall, 2013.
E-References:	
1.	https://umairbfrend.files.wordpress.com/2015/01/analogue-digital-communication-manual_august-2015.pdf
2.	https://stannescet.ac.in/cms/staff/qbank/ECE/Lab_Manual/EC8561-_COMMUNICATION_%20_SYSTEM_%20LABORATORY-2062944779-EC %20 8461%20communication%20systems%20manual.pdf
3.	www.vlab.co.in/ba-nptel-labs-electronics-and-communications

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Generate and analyse analog and digital modulated signals.	L4
CO2	Sample the given analog signal for various sampling frequency.	L4
CO3	Generate various line codes for digital signals.	L3
CO4	Multiplex and demultiplex digital signals	L3
CO5	Write codes for various analog and digital modulation schemes.	L3

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	2	1	2							1	2	2	2
CO2	1	2	2	1	2							1	1	2	2
CO3	1	2	2	1	2							1	2	2	2
CO4	1	2	2	1	2							1	1	2	2
CO5	2	2	2	1	2							1	2	2	2
Avg	2.8	2	2	1	2							1	1.6	2	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC701	WIRELESS AND MOBILE COMMUNICATION	Semester			VII
PREREQUISITES	**Category**	**PC**	**Credit**		**3**
Digital Communication	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To make the students understand the basics of wireless and mobile communication
2	To understand the basics and design if cellular system.
3	To have an insight into the various propagation models and the speech coders used in mobile communication

Unit I	**INTRODUCTION AND MODERN WIRELESS COMMUNICATION SYSTEMS**	**9**	**0**	**0**	**9**

Introduction to wireless communications - History and evolution – Mobile radio system around the world – Examples of common wireless communication systems - Trends in cellular radio and personal communications - Modern wireless communication systems: 2G Cellular networks – 3G wireless networks - 4G mobile web access - 5G faster wireless network - Wireless network standards.

Unit II	**THE CELLULAR CONCEPT:SYSTEM DESIGN FUNDAMENTALS AND MODULATION TECHNIQUES FOR MOBILE RADIO**	**9**	**0**	**0**	**9**

Frequency reuse - Channel Assignment strategies - Handoff strategies - Interference and system capacity -Trunking and grade of service - Improving coverage and capacity in cellular systems - Modulation: Combined linear and Constant envelope modulation techniques: Mary PSK,M_ary QAM,M_ary FSK and OFDM.

Unit III	**MOBILE RADIO PROPAGATION:LARGE SCALE PATH LOSS**	**9**	**0**	**0**	**9**

Introduction to Radio wave propagation - Free-space propagation model - 3 basic propagation mechanisms and models : reflection - Ground reflection model – Diffraction - Knife-edge diffraction model -Scattering – radar cross section model - Practical Link budget design using path loss models - Outdoor propagation models - Indoor propagation models

Unit IV	**MOBILE RADIO PROPAGATION:SMALL-SCALE FADING AND MULTIPATH FADING**	**9**	**0**	**0**	**9**

Small-Scale fading: Small scale multipath propagation - Impulse response model of a multipath channel - Small-scale multipath measurements - Parameters of mobile multipath channels – Types of small-scale fading- Introduction to shape factors: Angular spread - Angular constriction - Azimuthal Direction of maximum fading .

Unit V	**EQUALISATION,DIVERSITY AND CHANNEL CODING**	**9**	**0**	**0**	**9**

Equalisation: Fundamentals – Training a generic adaptive equalizer – Equalizers in a communication receivers -Survey of equalization - Linear equalizers - Nonlinear equalization - Algorithms for adaptive equalization – Diversity: Practical Space Diversity Considerations - Polarization diversity -Frequency diversity -Time diversity - RAKE receiver – coding: Speech coding –Vocoders - LPC-Choosing Speech Codecs for Mobile communication - GSM codec - USDC codec

Total (45L+0T)= 45 periods

Text Books:

1	Theodore S.Rappaport , “Wireless Communications:Principles and Practice”, 2nd Edition.”, Pearson,2012.
2	Simon Haykin, “Digital Communications” Student Edition, John Wiley & sons, 2008.

Reference Books:

1	A.Molisch,Wiley, "Wireless Communications", 2nd Edition, 2010.
2	V.K. Garg, "Principles and Applications of GSM", Pearson Edition.
3	V.K. Garg, "IS-95 CDMA and CDMA 2000", Pearson Edition.
4	S. Haykins, "Communication Systems", 5th Edition, John wiley, 2008.
E-References:	
1.	http://www.pdfsdownload.com/download-pdf-for-free/wireless+communication+rappaport
2.	https://www.oreilly.com/library/view/wireless-communications-principles/0130422320/
3.	https://en.wikipedia.org/wiki/Adaptive_equalizer

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Characterize a wireless channel and evolve the system design specifications and understand the difference between wireless compared to wired counterpart.	L2
CO2	Design a cellular system, with improved coverage and capacity with the cell structure based on the resource availability and traffic demands and able to calculate interference .	L3
CO3	Identify various propagation effects and calculate large scale path loss.	L3
CO4	Analyze small scale and multipath fading in mobile environment.	L2
CO5	Exploit multiple antenna techniques for capacity/performance gains and design equalizer	L2

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		1	1	2	1								1	2	1
CO2	2	1	2	2	1								1	2	2
CO3	1	1	1	1	1								1	2	1
CO4	1	1	2	1	1								1	2	1
CO5	1	1	1	1	1								1	2	1
Avg	1	1	1.4	1.4	1								1	2	1.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTEC702	HIGH SPEED NETWORKS	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the packet switching, ATM and Frame relay networks.
2	To know the techniques involved to support real-time traffic and congestion control.
3	To be familiar with different levels of quality of service to different applications.

Unit I	INTRODUCTION TO HIGH SPEED NETWORKS	9	0	0	9

The need for a protocol architecture – The TCP/IP protocol architecture – Internetworking – Packet switching networks – Frame Relay Networks – Asynchronous transfer mode: ATM Protocol Architecture, ATM logical Connections, ATM Cells, ATM Service Categories, AAL – High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fibre Channel – Wireless LANs: applications, requirements – Architecture of 802.11 .

Unit II	CONGESTION AND TRAFFIC MANAGEMENT	9	0	0	9

Queuing Analysis – Queuing Models – Single Server Queues – Effects of Congestion –Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

Unit III	TCP AND ATM CONGESTION CONTROL	9	0	0	9

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO back off – KARN's Algorithm – Window management – Performance of TCP over ATM – Traffic and Congestion control in ATM – Requirements – Attributes –Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.

Unit IV	INTEGRATED AND DIFFERENTIATED SERVICES	9	0	0	9

Integrated Services Architecture – Approach, Components, Services – Queuing Discipline: FQ, PS, BRFQ, GPS, WFQ – Random Early Detection – Differentiated Services.

Unit V	PROTOCOLS FOR QOS SUPPORT	9	0	0	9

RSVP – Goals and Characteristics, Data Flow, RSVP operations, Protocol Mechanisms – Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.

Total (45L)= 45 Periods

Text Books:

1. Warland, Pravin Varaiya, "High performance communication networks", Second Edition, Jean Harcourt Asia Pvt. Ltd, 2001.
2. William Stallings, "High speed networks and internets", Pearson Education, Second Edition, 2002.

Reference Books:

1	James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Pearson Education, Third Edition, 2011
2	IrvanPepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.
3	Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2004.
4	Kaven Pahlavan And Prashant Krishnamoorthy, "Principles Of Wireless Network", Prentice Hall Of India, 2010.
E-References:	
1.	http://freevideolectures.com/Course/2278/Data-Communication/30
2.	http://nptel.ac.in/courses/106105082/30
3.	https://nptel.ac.in/courses/106105183

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Compare ATM, Frame Relay and TCP/IP networks.	L4
CO2	Understand the concepts of queuing mechanism and congestion control techniques in packet switching and frame relay networks.	L2
CO3	Analyze the traffic management in TCP and ATM.	L4
CO4	Be familiar with the integrated and differentiated service architecture.	L1
CO5	Understand the protocols to support various levels of quality of service to different applications.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2		1	1	2	1					2		1	2	2
CO2	3		1	2	2	2							1	1	1
CO3	2		1	2	1	2							2	2	2
CO4	1		1	1	1	1							1	2	1
CO5	1		1	1	2	1					2		2	2	2
Avg	1.8		1	1.4	1.6	1.4					0.8		1.4	1.8	1.6
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

PROFESSIONAL ELECTIVES (PE)

22PTECE601	COMPUTER ARCHITECTURE		Semester			VI
PREREQUISITES		Category	PE	Credit		3
		Hours/Week	L	T	P	TH
			3			

Course Learning Objectives

1	To describe computer architecture concepts and mechanisms related to the design of modern processors, memories, and networks.
2	To understand various design alternatives and make a compelling quantitative and/or qualitative argument for why one design is superior to the other approaches.
3	To illustrate the fixed point and floating-point arithmetic of ALU operations.

Unit I	FUNDAMENTALS OF QUANTITATIVE DESIGN AND ANALYSIS	9	0	0	9

Introduction-Classes of Computers- Defining Computer Architecture- Trends in Technology- Trends in Power and Energy in Integrated Circuits-Trends in Cost - Dependability - Measuring, Reporting, and Summarizing Performance - Quantitative Principles of Computer Design - Putting It All Together: Performance, Price, and Power - Fallacies and Pitfalls.

Unit II	COMPUTER ARITHMETIC	9	0	0	9

Addition and subtraction of signed numbers - Design of fast adders - multiplication of positive numbers - signed operand multiplication, Booth algorithm - Fast multiplication - Bit pair recoding of the multiplier - Carry save addition - Integer division - Floating point numbers - Arithmetic operations on floating point numbers - Guard bits and truncation

Unit III	PROCESSING UNITS	9	0	0	9

Fundamental concepts – Execution of a complete Instruction – Multiple bus organization – Hardwired control – Micro programmed control - Pipelining – Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration – Superscalar operation – Performance considerations.

Unit IV	MEMORY SYSTEM	9	0	0	9

Basic concepts – semiconductor RAMs, ROMs – Speed, size and cost – Cache memories - Memory Hierarchy Design-Ten Advanced Optimizations of Cache Performance - Performance consideration – Virtual memory- Memory Management requirements – Secondary storage - CD-ROM - DVD_ROM - DVD drive - Hard drive

Unit V	DOMAIN-SPECIFIC ARCHITECTURES	9	0	0	9

Introduction - Guidelines for DSAs - Example Domain: Deep Neural Networks - The Neurons of DNNs-Training Versus Inference-Multilayer Perceptron - Convolutional Neural Network -Recurrent Neural Network – Batches – Quantization-Google's Tensor Processing Unit, an Inference Data Center Accelerator -TPU Architecture - TPU Instruction Set Architecture - TPU Microarchitecture

Total(L+T) =45 Periods

Text Books:

1	John Hennessy, David Patterson ,"Computer Architecture A Quantitative Approach",6th Ed, Morgan Kaufmann Publishers,2019.

2	Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization" 5th Ed, McGraw Hill, 2001.
Reference Books:	
1	William Stallings, "Computer Organization and Architecture – Designing for Performance", 10th Edition, Pearson, 2016.
2	David A. Patterson and John L.Hennessy, "Computer Organization and Design, the hardware / software interface", 5th edition, Morgan Kaufmann, Elsevier, 2014.
3	Caxton C. Foster, "Computer Architecture", 6th Edition, Van Nostrand Reinhold Company.
4	AndrewS.Tanenbaum,Todd Austin,"Structured Computer Organization", 6th Edition, Pearson, 2013.
E-References:	
1.	http://nptel.ac.in/courses/106102062/
2.	https://www.coursera.org/learn/comparch/home/week/1

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Recognize the trends followed in designing architecture.	L2
CO2	Illustrate the fixed point and floating-point arithmetic for ALU operation.	L1
CO3	Analyse the pipeline performance considering the hazards by computing clock cycles.	L4
CO4	Differentiate the types of memory and use suitable type for architecture development	L3
CO5	Recommend domain-specific architectures like DNN and TPU for a new application	L3

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		2		2									2	1	2
CO2	2		3	2									1		
CO3	1		2										2		2
CO4	2	2	2	2	2								2		3
CO5		2	2		2								2	1	3
Avg	1	1.2	1.8	1.2	0.8								1.8	0.4	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE602	MODERN SENSORS AND ITS APPLICATIONS	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To know various stimuli that are to be measured in real life instrumentation.
2	Able to select the right process or phenomena on which the sensor should depend on
3	Aware of the various sensors available for measurement and control applications.

Unit I	INTRODUCTION TO SENSORS AND TRANSDUCERS	9	0	0	9

Introduction to sensors and transducers- Need for sensors in the modern world. Different fields of sensors based on the stimuli - various schematics for active and passive sensors. Static and dynamic characteristics of sensors - zero, I and II order sensors – Response to impulse, step, ramp and sinusoidal inputs. Environmental factors and reliability of sensors.

Unit II	MECHANICAL SENSORS	9	0	0	9

Sensors for mechanical systems or mechanical sensors - Displacement - acceleration and force - flow of fluids - level indicators - pressure in fluids - stress in solids. Typical sensors - wire and film strain gauges, anemometers, piezo electric and magnetostrictive accelerometers, potentio metric sensors, LVDT

Unit III	THERMAL AND OPTICAL SENSORS	9	0	0	9

Thermal Sensors: Temperature – temperature difference – heat quantity. Thermometers for different situation – thermocouples thermistors – color pyrometry. **Optical sensors**: light intensity – wavelength and color – light dependent resistors, photodiode, photo transistor, CCD, CMOS sensors. **Radiation detectors**: radiation intensity, particle counter – Gieger Muller courter (gas based), Hallide radiation detectors

Unit IV	MAGNETIC AND ACOUSTIC SENSORS	9	0	0	9

Magnetic Sensors: magnetic field, magnetic flux density – magneto resistors, Hall sensors, super conduction squids. **Acoustic or sonic sensors**: Intensity of sound, frequency of sound in various media, various forms of microphones, piezo electric sensors

Unit V	ELECTRICAL AND HIGH FREQUENCY SENSORS	9	0	0	9

conventional volt and ammeters, high current sensors, (current transformers), high voltage sensors, High power sensors. High frequency sensors like microwave frequency sensors, wavelength measuring sensors. MEMs and MEM based sensors.

Total (45+15) = 60 Periods

Text Books:

1	Doebelin, “Measurement Systems: Application and Design”, McGraw Hill Kogakusha Ltd.
2	Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim “Microsensors, MEMS and Smart Devices”, New York: Wiley, 2001.

Reference Books:

1	Henry Bolte, “Sensors – A Comprehensive Sensors”, John Wiley.
2	Jocob Fraden,” Handbook of Modern Sensors, Physics, Designs, and Applications”, Springer.
3	Manabendra Bhuyan,” Intelligent Instrumentation Principles and Applications”, CRC Press.
4	Randy Frank,” Understanding Smart Sensors”, Second edition, Artech House.
E-References:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee50
2.	https://www.youtube.com/watch?v=hmP5CSIendo
3.	https://kanchiuniv.ac.in/wp-content/uploads/2021/05/BMTF183T60-SENSORS-AND-ACTUATORS-1.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Appreciate the operation of various measuring and control instruments which they encounter in their respective fields.	L2
CO2	Visualize the sensors and the measuring systems when they have to work in areas of interdisciplinary nature and also think of sensors and sensors systems when for a new situation they encounter in their career	L3
CO3	Identify and select the right process or phenomena on which the sensor should depend on.	L4
CO4	Know various stimuli that are to be measured in real life instrumentation.	L3
CO5	Identify the sensors and its applications	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1		1	2	2							2		1	2	1
CO2		1	2	2							2		1	2	1
CO3		2	3	2							2		2	1	2
CO4		2	3	3							2		2	1	2
CO5		1	2	3							1		1	2	1
Avg		1.4	2.4	2.4							1.8		1.4	1.6	1.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE603	ADVANCED MICROCONTROLLER	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To learn microcontroller basics and get exposure to different types of architecture
2	To embed and program with ARM microcontrollers
3	To introduce the advanced features in microprocessor and microcontrollers

Unit I	HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM	9	0	0	9

CPU Architecture- Bus Operations – Pipelining – Brach predication – floating point unit- Operating Modes –Paging – Multitasking – Exception and Interrupts – Instruction set – addressing modes – Programming the Pentium processor.

Unit II	HIGH PERFORMANCE RISC ARCHITECTURE – ARM	9	0	0	9

ARM Embedded Systems- RISC and ARM Design Philosophy–ARM Processor Fundamentals-Registers –PSW – Pipeline - Exceptions, interrupts and the vector table- ARM Processor Families - ARM instruction set

Unit III	PROGRAMMING WITH ARM	9	0	0	9

Introduction to Thumb Instruction set – ARM Assembly Language Programming – C programming – Optimizing ARM Assembly Code.

Unit IV	ARM STM32F4 and MOTOROLA 68HC11 MICROCONTROLLERS	9	0	0	9

STM32F4 Microcontroller- CPU- Memory- input and output ports – Modules- Assembly language – the STM32F4 Board. Motorola 68HC11 Instruction set -addressing modes – operating modes- Interrupt system- RTC-Serial Communication Interface

Unit V	PIC MICROCONTROLLER	9	0	0	9

CPU Architecture – Instruction set – interrupts- Timers- I2C Interfacing –UART- A/D Converter –PWM and introduction to C-Compilers.

Total (45+15) = 60 Periods

Text Books:

1	Andrew N.Sloss, Dominic Symes and Chris Wright " ARM System Developer"s Guide : Designing and Optimizing System Software" , First edition, Morgan Kaufmann Publishers, 2004.
2	Cem Unsalan, Huseyin Deniz Gurhan and Mehmet Erkin Yucel, ""Embedded system design with ARM Cortex-M Microcontrollers", Springer Nature Switzerland,2022.

Reference Books:

1	Steve Furber , "ARM System –On –Chip architecture", Addision Wesley, 2000.

2	Ying Bai, “Practical Microcontroller Engineering with ARM Technology”, Wiley, 2015.
3	Nicolas K. Haddad, “Microcontroller System Design Using PIC18F Processors’, IGI Global,2017.
4	Gene .H.Miller, “Micro Computer Engineering”, Pearson Education , 2004.
E-References:	
1.	https://www.mouser.in/new/semiconductors/embedded-processors-controllers/microcontrollers-mcu/n-a85i8
2.	https://www.coursera.org/learn/embedded-software-hardware

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Recognize suitable microcontroller architecture for a real world application.	L2
CO2	Analyse the architecture of ARM STM32F4 and MOTOROLA 68HC11 Microcontrollers.	L4
CO3	Develop programs for ARM for performing a real world task.	L3
CO4	Use suitable addressing mode for a problem.	L3
CO5	Interface PIC microcontrollers with external peripherals	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1		2		2									3		2
CO2		2				1									1
CO3	2			3									2		3
CO4		3		2									2		1
CO5		3		1									2		2
Avg	0.4	2		1.6		0.2							1.8		1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE604	INTERNET OF THINGS	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the vision of M2M to IOT.
2	To gain an understanding of IOT market perspective.
3	To acquire knowledge on IoT Technology Fundamentals and applications
4	To build small system using Raspberry Pi.

Unit I	M2M TO IoT – The Vision	9	0	0	9

Introduction - From M2M to IoT- M2M towards IoT: M2M Communication - The global context - A use case example – Differing Characteristics.

Unit II	M2M to IoT – a Market Perspective	9	0	0	9

Introduction - Some Definitions - M2M Value Chains - IoT Value Chains - An emerging industrial structure for IoT- 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 III	IoT Technology Fundamentals	9	0	0	9

IoT Enabling technologies – IoT levels and deployment templates - Devices and gateways - Data management - Business Processes in IoT - Everything as a Service (XaaS) - M2M and IoT Analytics.

Unit IV	Building IoT with Hardware Platforms	9	0	0	9

IoT Systems-Logical Design using Python –IoT Physical Devices and End Points- IoT Device - Raspberry Pi - Interfaces – Programming – Other IoT devices - IoT Reference Model - Real World Design Constraints.

Unit V	IoT Use Cases and Applications	9	0	0	9

Home automation-Automatic lighting-Home intrusion detection- Cities-Smart parking – Environment – Weather monitoring system-Air pollution Monitoring-Forest Fire Detection- Agriculture- Smart irrigation. Commercial Building Automation – Introduction - Case study (Phase one) : Commercial building automation today - Case study (Phase two) - Commercial building automation in the future.

Total(L+T)=45 Periods

Text Books:

1	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2	Arshdeep Bahga, Vijay Madisetti, “Internet of Things-A hands-on approach”, Universities Press, 2015

Reference Books:

1	Olivier Hersent, davidBoswarthick, Omar Elloumi, 'The Internet of Things Applications to the smart grid and building automation', John Wiley & Sons, 2012.
2	Francis daCosta, "Rethinking the Internet of Things : A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
3	HakimaChaouchi, 'The Internet of Things Connecting Objects', John Wiley & Sons, 2010.
4	FabriceTheoleyr, Ai-Chun Pang, 'Internet of Things and M2M Communications', River Publishers, 2013.
E-References:	
1.	https://nptel.ac.in/courses/106105166
2.	https://nptel.ac.in/courses/108108098
3.	https://onlineitguru.com/IoT-online-training.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the vision of IoT from a global context.	L2
CO2	Determine the Market perspective of IoT.	L1
CO3	Understand the IoT technology fundamentals.	L2
CO4	Build small system using Raspberry Pi.	L3
CO5	Analyse applications of IoT and case studies	L4

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
COs/POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO 12	PSO 1	PS O2	PS O3
CO1		1			2										
CO2	2	2	2	2	2							1	1		
CO3	2	2	2	2	2							1	1		
CO4	2	2	2	2	2						2	2	2		
CO5	2	2	2	2	2						2		2		2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE605	NANO ELECTRONICS	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates
2	To explore the basics of nanomaterial synthesis and characterization
3	To introduce the applications of nanotechnology.

Unit I	INTRODUCTION TO NANO TECHNOLOGY	9	0	0	9

Microelectronics towards biomolecule electronics - Particles and waves - Wave-particle duality - Wave mechanics - Schrödinger wave equation - Wave mechanics of particles: Atoms and atomic orbitals Materials for nanoelectronics- Semiconductors- Crystal lattices: Bonding in crystals- Electron energy bands- Semiconductor heterostructures- Lattice-matched and pseudomorphic heterostructures - Inorganic-organic heterostructures.

Unit II	FUNDAMENTALS OF NANOELECTRONICS	9	0	0	9

Fundamentals of logic devices Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain.

Unit III	NANO PROPERTIES	9	0	0	9

Dielectrics-Ferroelectrics-Electronic Properties and Quantum Effects-Magneto electronics – Magnetism and Magneto transport in Layered Structures-Organic Molecules – Electronic Structures, Properties, and Reactions-Neurons – The Molecular Basis of their Electrical Excitability-Circuit and System Design Analysis by Diffraction and Fluorescence Methods.

Unit IV	NANO STRUCTURE DEVICES	9	0	0	9

Electron transport in semiconductors and nanostructures- Time and length scales of the electrons in solids- Statistics of the electrons in solids and nanostructures- Density of states of electrons in nanostructures- Electron transport in nanostructures- Electrons in traditional Low-dimensional structures. Electrons in quantum wires- Electrons in quantum dots- Nanostructure devices- Resonant-tunneling diodes- Field-effect transistors- Single-electron-transfer devices- Potential effect transistors- Nano-electromechanical system devices.

Unit V	MOLECULAR ELECTRONICS	9	0	0	9

Electrodes & contacts – functions – molecular electronic devices – first test systems –simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

Total(L+T)=45 Periods

Text Books:

1	Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, “Introduction to Nanoelectronics: Science, Nano technology, Engineering, and Applications”, Cambridge University Press 2011.

2	Supriyo Datta, “Lessons from Nano electronics: A New Perspective on Transport”, World Scientific 2012.
Reference Books:	
1	George W. Hanson, “Fundamentals of Nano electronics”, Pearson 2009.
2	Korkin, Anatoli; Rosei, Federico (Eds.), “Nano electronics and Photonics”, Springer 2008.
3	Mircea Dragoman, Daniela Dragoman, “Nano electronics: principles and devices”, CRC Press 2006
4	Karl Goser, Peter Glösekötter, Jan Dienstuhl, “Nano electronics and Nano systems: From Transistors to Molecular and Quantum Devices”, Springer 2004
E-References:	
1.	https://www.kth.se/social/upload/54062f97f2765416cecdfd74/HT14-IM2655_Lecture%201.pdf
2.	https://mitocw.ups.edu.ec/courses/electrical-engineering-and-computer-science/6-701-introduction-to-nanoelectronics-spring-2010/readings/MIT6_701S10_notes.pdf
3.	https://nanohub.org/resources/8340/supportingdocs

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	To understand the basics of nanotechnology and different fabrications methods.	L2
CO2	To understand the behaviour of nanomaterials and related structures.	L1
CO3	To analyze and design nanostructure devices and logic circuits.	L4
CO4	To discuss applications and specific properties of nanomaterials.	L3
CO5	To know nanoelectronics holds the capacity for mass production of high-quality nanodevices.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	-	2	-	2		2					1		1
CO2			3	-		2		1						2	
CO3	2	3	3	2											2
CO4	1			-	2		3						1		
CO5	2	3	3	2		2		2							1
Avg															
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE606	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To provide a strong foundation of fundamental concepts in Artificial Intelligence.
2	To enable the student to apply these techniques in applications which involve perception, reasoning and learning.
3	To enable Problem-solving through various searching techniques.

Unit I	INTRODUCTION TO Al AND PRODUCTION SYSTEMS	9	0	0	9

Introduction to AI-Problem formulation - Problem Definition - Production systems - Control strategies - Search strategies - Problem characteristics - Production system characteristics - Specialized production system - Problem solving methods - Problem graphs – Matching - Indexing and Heuristic functions - Hill Climbing - Depth first and Breath first - Constraints satisfaction - Related algorithms - Measure of performance and analysis of search algorithms.

Unit II	REPRESENTATION OF KNOWLEDGE	9	0	0	9

Game playing - Knowledge representation - Knowledge representation using Predicate logic - Introduction to predicate calculus – Resolution - Use of predicate calculus - Knowledge representation using other logic -Structured representation of knowledge. .

Unit III	KNOWLEDGE INFERENCE	9	0	0	9

Knowledge representation - Production based system - Frame based system - Inference - Backward chaining- Forward chaining -Rule value approach -Fuzzy reasoning - Certainty factors - Bayesian Theory - Bayesian Network -Dempster - Shafer theory.

Unit IV	PLANNING AND MACHINE LEARNING	9	0	0	9

Basic plan generation systems - Strips - Advanced plan generation systems – K strips - Strategic explanations- Why, Why not and how explanations - Learning - Machine learning - Adaptive Learning.

Unit V	EXPERT SYSTEMS	9	0	0	9

Expert systems - Architecture of expert systems - Roles of expert systems - Knowledge Acquisition – Meta knowledge- Heuristics - Typical expert systems – MYCIN - DART - XOON - Expert systems shells.

Total(L+T) =45 Periods

Text Books:

1	Stuart Russell, Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Pearson Education / Prentice Hall of India, 2010.
2	Elaine Rich and Kevin Knight, “Artificial Intelligence”, Third Edition, Tata McGraw-Hill, 2010.

Reference Books:

1	Ethem Alpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning series)”, The MIT Press; Second edition, 2009.
2	Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition, 2006.

3	David L. Poole, Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010.
4	"Machine Learning"by Rajiv Chopra, Khanna Publishing; First edition, 2018.
E-References:	
1.	https://www.coursera.org/learn/machine-learning
2.	https://www.coursera.org/courses?query=artificial%20intelligence
3.	https://www.udemy.com/machine-learning-course-with-python/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Provides a basic exposition to the goals and methods of Artificial Intelligence	L1
CO2	Study of the design of intelligent computational agents	L2
CO3	The knowledge acquired through learning can be used both for problem solving and for reasoning planning, natural language understanding, computer vision, automatic programming and machine learning.	L3
CO4	Implement various expert system	L6
CO5	To take of projects in the domain	L6

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO2	2	2	1	2	-	-	-	-	-	-	-	-	2	2	1
CO3	2	3	1	2	3	-	-	-	-	-	-	-	2	3	1
CO4	2	-	2	2	3	2	-	-	-	-	-	-	2	-	2
CO5	2	-	2	2	3	2	-	-	-	-	-	-	2	-	2
Avg	2	1.2	1.4	1.6	1.8	0.8							2	1.2	1.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE607	ARTIFICIAL NEURAL NETWORK	Semester			VI
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To provide a strong foundation of fundamental concepts in Artificial Neural Network
2	To get into various applications in signal and image processing and pattern recognition.
3	To understand testing, training, learning and various error functions.

Unit I	INTRODUCTION	9	0	0	9

Human Brain, Models of a Neuron, Neural networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks. Learning process 1 – Error Correction learning, Memory based learning, Hebbian learning.

Unit II	LEARNING PROCESS AND SINGLE LAYER PERCEPTRONS	9	0	0	9

Learning process 2: Competitive, Boltzmann learning, Credit Assignment Problem, Memory, Adaption, Statistical nature of the learning process. SINGLE LAYER PERCEPTRONS – Adaptive filtering problem, Unconstrained Organization Techniques, Linear least square filters, least mean square algorithm, learning curves, Learning rate annealing techniques, perceptron, perceptron – convergence theorem, Relation between perceptron and Bayes classifier for a Gaussian Environment

Unit III	THE MULTILAYER PERCEPTRON	9	0	0	9

Feed-forward network mappings, Threshold units, Sigmoidal units, weight-space symmetries, higher order networks, Kolmogorov's theorem, Error back propagation, The Jacobian matrix, The Hessian matrix.

Unit IV	RADIAL BASIS FUNCTIONS AND ERROR FUNCTIONS	9	0	0	9

Radial Basis Functions - Exact interpolation, Radial basis function networks, Network training, Radial basis function networks for classification, Comparison with the multi-layer perceptron, Basis function optimization. Error Functions - Sum-of-squares error, modelling conditional distributions, Estimating posterior probabilities, Sum-of-squares for classification.

Unit V	SELF ORGANIZATION MAPS	9	0	0	9

Two basic feature mapping models, Self-organization map, SOM algorithm, properties of feature map, computer simulations, learning vector quantization, Adaptive pattern classification, Hierarchical Vector quantizer, contextual Maps

Total (45+15) = 60 Periods

Text Books:

1	Simon Haykin, "Neural networks A comprehensive foundations", Pearson Education 2nd Edition 2004.
2	Cristopher M. Bishop, "Neural Networks for pattern recognition", Clarendon Press, Oxford, 2005.

Reference Books:

1	B.Vegnanarayana," Artificial neural networks", Prentice Hall of India, 2006.

2	Simon Haykin, “Neural networks and learning systems”, Pearson Education 3rd Edition 2016
3	James A Freeman, David M S Kapura,” Neural networks” Pearson Education 2004
4	Kevin L. Priddy, Paul E.Keller, “Artificial neural networks an introduction”, SPIE Press, 2005.
E-References:	
1.	https://towardsdatascience.com/an-introduction-to-artificial-neural-networks-5d2e108ff2c3
2.	https://en.wikipedia.org/wiki/Artificial_neural_network
3.	https://www.analyticsvidhya.com/blog/2021/07/understanding-the-basics-of-artificial-neural-network-ann/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand the basic models of artificial neuron.	L2
CO2	Gain knowledge on learning process in neural networks and design single layer perceptron.	L1
CO3	Design multi-layer perceptron and back propagation networks.	L3
CO4	Find solutions to complex problems using RBF networks and SOM	L3
CO5	To take up projects in the domain	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	-	-	1	-	-	-	-	-	-	2	2	2
CO2	2	2	1	2	-	2	-	-	-	-	-	-	2	2	2
CO3	2	2	1	2	3	-	-	-	-	-	-	-	2	2	2
CO4	2	1	2	2	3	-	-	-	-	-	-	-	2	2	2
CO5	2	1	2	2	3	2	-	-	-	-	-	-	2	2	2
Avg	2	1.4	1.4	1.2	1.8	1	-	-	-	-	-	-	2	2	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE701	DIGITAL IMAGE PROCESSING	Semester			VII
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
Digital Signal Processing	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To study the fundamentals and mathematical transforms necessary for image processing.
2	To study the image enhancement and restoration techniques.
3	To study the image segmentation, representation and compression procedures.

Unit I	**DIGITAL IMAGE PROCESSING**	**9**	**0**	**0**	**9**

Two dimensional signals and systems - Mathematical preliminaries-Elements of Digital Image Processing System - Structure of the human eye - Image formation and contrast sensitivity - Sampling and Quantization - Neighbours of pixel – Distance measures – Image processing applications.

Unit II	**IMAGE TRANSFORMS**	**9**	**0**	**0**	**9**

Introduction to Fourier transform - Discrete Fourier transform - Properties of DFT– Separability, Translation, Periodicity, Rotation, Average Value – Discrete Cosine Transform – Properties - Haar Transform.

Unit III	**IMAGE ENHANCEMENT AND RESTORATION**	**9**	**0**	**0**	**9**

Enhancement in spatial domain - Histogram Equalization technique - Spatial Filtering – Low pass filtering – Median filtering – Sharpening Filters - Enhancement in frequency domain - Homomorphic filtering – Image Restoration - Degradation model - Noise models - Inverse Filtering - Unconstrained and constrained Restoration methods.

Unit IV	**IMAGE SEGMENTATION AND REPRESENTATION**	**9**	**0**	**0**	**9**

Point, Line and Edge detections - Gradient operators - Thresholding – Region-Oriented Segmentation - Representation schemes: chain codes - Polygon approximation - Boundary descriptors: Simple descriptors - Shape numbers Fourier descriptors.

Unit V	**IMAGE COMPRESSION**	**9**	**0**	**0**	**9**

Coding, Inter pixel and Psychovisual redundancies – Fidelity criteria – Image Compressions models – Variable length coding – Bit plane coding – Lossless and Lossy Predictive coding – Transform coding techniques – Image compression standards.

Total(L+T) =45 Periods

Text Books:

1	Rafael C Gonzalez and Richard E Woods, Digital Image Processing, 4th Edition - Pearson, 2018.
2	Jayaraman S, Esakkirajan S and Veerakumar T, Digital Image Processing, Tata McGraw Hill, New Delhi, 2017.

Reference Books:

1	Kenneth R Castleman, Digital Image Processing, Prentice Hall, New Delhi, 2008.
2	Sid Ahmed M A, Image Processing Theory, Algorithm and Architectures, McGraw-Hill,New Delhi, 1995

3	Rafael C Gonzalez, Richard E.woods and Steven L. Eddins, Digital Image Processing Using MATLAB, 2nd Edition, Tata McGraw Hill, New Delhi, 2017.
4	Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Procesing, Analysis, and Machine Vision, Brooks/Cole, Singapore, 2008.
E-References:	
1.	https://nptel.ac.in/courses/117105135
2.	https://nptel.ac.in/courses/117105079
3.	https://www.youtube.com/watch?v=uvXTZxSzdMk

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Know and understand the concepts of digital image processing.	L2
CO2	Analyze various images transforms.	L4
CO3	Demonstrate the understanding of image enhancement and restoration algorithms.	L3
CO4	Interpret image segmentation and representation techniques.	L3
CO5	Categorize various compression techniques and Interpret Image compression standards.	L4

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2			1	2								1		1
CO2	3			2	2								2		1
CO3	3	2		3	2								2	1	1
CO4	3	2		3	2								1	1	1
CO5	3	2	2	3	2								2	1	1
Avg	2.8	1.2	0.4	2.4	2								1.6	0.6	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE702	SOFTWARE DEFINED RADIO	Semester	VII
PREREQUISITES	Category	PE	Credit 3

	L	T	P	TH
Hours/Week	3	0	0	3

Course Learning Objectives

1	To understand the evolving software defined radio and cognitive radio techniques and their essential functionalities
2	To study the basic architecture and standard for cognitive radio
3	To expose the student to evolving applications and advanced features of cognitive radio

Unit I	INTRODUCTION TO SOFTWARE DEFINED RADIO	9	0	0	9

Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memory less channels – BEC – Channel capacity.

Unit II	SDR ARCHITECTURE	9	0	0	9

Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules

Unit III	INTRODUCTION TO COGNITIVE RADIOS	9	0	0	9

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

Unit IV	COGNITIVE RADIO ARCHITECTURE	9	0	0	9

Cognitive Radio - functions, components and design rules, Cognition cycle - orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture

Unit V	ADVANCED TOPICS IN COGNITIVE RADIO	9	0	0	9

Overview of security issues in cognitive radios, auction based spectrum markets in cognitive radio networks, public safety and cognitive radio, cognitive radio for Internet of Things.

Total (45+15) = 60 Periods

Text Books:

1	JosephMitolaIII,"Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000
2	Huseyin Arslan (Ed.), ―Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.

Reference Books:

1	HasariCelebi, HuseyinArslan, "Enabling Location and Environment Awareness in Cognitive Radios", Elsevier Computer Communications, Jan 2008.
2	Markus Dillinger, KambizMadani, Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003.
3	Kwang-Cheng Chen, Ramjee Prasad, ― Cognitive Radio Networks‖, John Wiley and Sons, 2009.
4	Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, "Cognitive Radio Communication and Networks", Elsevier, 2010.

E-References:	
1.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%201%20notes.pdf
2.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%20II%20notes.pdf
3.	https://www.rcet.org.in/uploads/files/LectureNotes/ece/S7/cognitive%20radio/UNIT%20V%20notes.pdf

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Gain knowledge on the design principles on software defined radio and cognitive radio	L2
CO2	Develop the ability to design and implement algorithms for cognitive radio spectrum sensing and dynamic spectrum access	L1
CO3	Gain knowledge and understanding of software defined radio architecture.	L2
CO4	Apply the knowledge of advanced features of cognitive radio for real world applications	L3
CO5	Gain knowledge on the advanced methods of cognitive radio.	L1

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3		2	2	2	2		1					2	1	
CO2	3	3	3			2	2	1					1		2
CO3	2	3		2	2	3			2					2	
CO4	1			3	1		3						1		
CO5	3	3	2	2		1		3							1
Avg															
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE703	ROBOTICS	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the basic concepts associated with the design, functioning, applications and social aspects of robots
2	To study about the electrical drive systems and sensors used in robotics for various applications and analyze analyzing robot kinematics, dynamics through different methodologies and study various design aspects of robot arm manipulator and end-effector
3	To learn about various motion planning techniques and the associated control architecture and to implement of AI and other trending concepts of robotics

Unit I	FOUNDATION FOR BEGINNERS	9	0	0	9

Introduction - brief history, definition, anatomy, types, classification, specification and need based applications; role and need of robots for the immediate problems of the society, future of mankind and automation-ethical issues; industrial scenario local and global, case studies on mobile robot research platform and industrial serial arm manipulator

Unit II	BUILDING BLOCKS OF A ROBOT	9	0	0	9

Types of electric motors - DC, Servo, Stepper; specification, drives for motors - speed & direction control and circuitry, Selection criterion for actuators, direct drives, non-traditional actuators; Sensors for localization, navigation, obstacle avoidance and path planning in known and unknown environments – optical, inertial, thermal, chemical, biosensor, other common sensors; Case study on choice of sensors and actuators for maze solving robot and self driving cars

Unit III	KINEMATICS, DYNAMICS AND DESIGN OF ROBOTS & END-EFFECTORS	9	0	0	9

Robot kinematics - Geometric approach for 2R, 3R manipulators, homogenous transformation using D-H representation, kinematics of WMR, Lagrangian formulation for 2R robot dynamics; Mechanical design aspects of a 2R manipulator, WMR; End-effector - common types and design case study.

Unit IV	NAVIGATION, PATH PLANNING AND CONTROL ARCHITECTURE	9	0	0	9

Mapping & Navigation – SLAM, Path planning for serial manipulators; types of control architectures - Cartesian control, Force control and hybrid position/force control, Behaviour based control, application of Neural network, fuzzy logic, optimization algorithms for navigation problems, programming methodologies of a robot.

Unit V	AI AND OTHER RESEARCH TRENDS IN ROBOTICS	9	0	0	9

Application of Machine learning - AI, Expert systems; Tele-robotics and Virtual Reality, Micro & Nanorobots, Unmanned vehicles, Cognitive robotics, Evolutionary robotics, Humanoids

Total(L+T)=45 Periods

Text Books:

1	Saeed. B. Niku, Introduction to Robotics, Analysis, system, Applications, Pearson educations, 2002
2	Roland Siegwart, Illah Reza Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2011

Reference Books:

1	Richard David Klafter, Thomas A. Chmielewski, Michael Negin, Robotic engineering: an integrated approach, Prentice Hall, 1989
2	Craig, J. J., Introduction to Robotics: Mechanics and Control, 2nd Edition, Addison-Wesley, 1989.
3	K.S. Fu, R.C. Gonzalez and C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
4	Wesley E Snyder R, Industrial Robots, Computer Interfacing and Control, Prentice Hall International Edition, 1988.
E-References:	
1.	https://www.edx.org/learn/robotics
2.	https://www.learnrobotics.org/blog/learn-robotics-guide/
3.	https://www.javatpoint.com/robotics-tutorial

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Explain the concepts of industrial robots in terms of classification, specifications and coordinate systems, along with the need and application of robots & automation	L1
CO2	Examine different sensors and actuators for applications like maze solving and self driving cars.	L4
CO3	Design a 2R robot & an end-effector and solve the kinematics and dynamics of motion for robots.	L6
CO4	Explain navigation and path planning techniques along with the control architectures adopted for robot motion planning	L1
CO5	Describe the impact and progress in AI and other research trends in the field of robotics	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	-	1	1	-	-	-	-	-	-	2	2	2
CO2	2	2	1	2	2	2	-	-	-	-	-	-	2	2	2
CO3	2	2	1	2	3	-	-	-	-	-	-	-	2	2	2
CO4	3	1	2	2	3	-	-	-	-	-	-	-	2	2	2
CO5	3	1	2	2	3	2	-	-	-	-	-	-	2	2	2
Avg	2.4	1.4	1.4	1.6	2.4	1							2	2	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE704	WIRELESS NETWORKS	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the concept about Wireless networks, protocol stack and standards
2	To understand and analyse the network layer solutions for Wireless networks
3	To study about fundamentals of 3G Services, its protocols and applications
4	To have in depth knowledge on internetworking of WLAN and WWAN
5	To learn about evolution of 4G Networks, its architecture and applications

Unit I	WIRELESS LAN	9	0	0	9

Introduction-WLAN technologies: - IEEE802.11: System architecture, protocol architecture, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, WPAN – IEEE 802.15.4, Wireless USB, Zigbee, 6LoWPAN, Wireless HART

Unit II	MOBILE NETWORK LAYER	9	0	0	9

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing: Destination Sequence distance vector, IoT: CoAP

Unit III	3G OVERVIEW	9	0	0	9

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3GPP Architecture, User equipment, CDMA2000 overview- Radio and Network components, Network structure, Radio Network, TD-CDMA, TD – SCDMA.

Unit IV	INTERNETWORKING BETWEEN WLANS AND WWANS	9	0	0	9

Internetworking objectives and requirements, Schemes to connect WLANS and 3G Networks, Session Mobility, Internetworking Architecture for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution System.

Unit V	4G & Beyond	9	0	0	9

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO

Total (45+15) = 60 Periods

Text Books:

1	Jochen Schiller, ”Mobile Communications”, Second Edition, Pearson Education 2012.(Unit I,II,III)
2	Vijay Garg, “Wireless Communications and networking”, First Edition, Elsevier 2007.(Unit IV,V)

Reference Books:

1	Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband”, Second Edition, Academic Press, 2008.

2	Anurag Kumar, D.Manjunath, Joy kuri, “Wireless Networking”, First Edition, Elsevier 2011 .
3	Simon Haykin , Michael Moher, David Koilpillai, “Modern Wireless Communications”, First Edition, Pearson Education 2013
E-References:	
1.	https://nptel.ac.in/courses/117104099
2.	https://nptel.ac.in/courses/106106167
3.	https://study.com/academy/lesson/types-of-networks-lan-wan-wlan-man-san-pan-epn-vpn.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand wireless network environment for any application using latest standards	L2
CO2	Design and implement the environment using latest wireless protocols.	L2
CO3	Conversant with the latest 3G networks and its architecture	L2
CO4	Implement different type of applications for smart phones and mobile devices with latest network strategies	L2
CO5	Familiar with the latest 4G networks and its architecture	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	3	3	3	2				3	3	3		2
CO2	3	3	2	3	3	3	2				3	3	3		2
CO3	3	3	3	3	3	3	2				3	3	3		2
CO4	3	3	2	3	3	3	2				2	3	3		2
CO5	3	3	2	3	3	3	2				3	3	3		2
Avg	**3**	**3**	**2**	**3**	**3**	**3**	**2**				**2.8**	**3**	**3**		**2**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE705	VIRTUAL INSTRUMENTATION	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To review background information required for studying virtual instrumentation
2	To study the basic building blocks of virtual instrumentation.
3	To study the various techniques of interfacing of external instruments of PC.
4	To study the various graphical programming environment in virtual instrumentation
5	To study a few applications in virtual instrumentation.

Unit I	OVERVIEW OF VIRTUAL INSTRUMENTATION	9	0	0	9

Historical perspective and traditional bench-top instruments - General functional description of a digital instrument- Block diagram of a Virtual Instrument – Physical quantities and analog interfaces- Hardware and Software – User Interfaces - Advantages of Virtual Instruments over conventional instruments – Architecture of a Virtual Instruments and its relation to the operating system.

Unit II	LABVIEW PROGRAMMING TOOLS	9	0	0	9

LabVIEW – graphical user interfaces- controls and Indicators – _G' programming –data types –data flow programming –Editing Debugging and Running a Virtual Instrument –Graphical programming palettes and tools – Front panel objects – Function and Libraries.

Unit III	CONDITIONAL OPERATIONS	9	0	0	9

FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes-Sequence structures- Arrays and Clusters- Array operations – Bundle, Unbundle – Bundle/Unbundle by name, graphs and charts – string and file I/O – High level and Low level file I/Os – attribute nodes local and global variables.

Unit IV	INSTALLATION PROCESS	9	0	0	9

Basics of DAQ Hardware and Software – Concepts of Data Acquisition and terminology – Installing Hardware, Installing drivers -Configuring the Hardware – addressing the hardware in LabVIEW- Digital and Analog I/O function – Buffered I/O–Real-time Data Acquisition..

Unit V	GRAPHICAL PROGRAMMING	9	0	0	9

Simple programs in VI- Advanced concepts in LabVIEW- TCP/IP VI's, Synchronization – other elements of Virtual Instrumentation – Bus extensions – PXI - Computer based instruments - Image acquisition–Motion Control.

Total (45+15) = 60 Periods

Text Books:

1	Garry M. Johnson, ―LabVIEW Graphical Programming‖, Tata McGraw-Hill, Edition, 1996
2	Lisa.K.Wills, ―LabVIEW for Everyone‖ Prentice Hall of India, 1996

Reference Books:

1	Labview Basics I and II Manual, National Instruments,2003
2	Barry Paton, ―Sensor, Transducers and Lab VIEW‖, Prentice Hall, 2000
3	S. Sumathi, P. Surekha, LabVIEW based advanced instrumentation systems, Springer Publication
4	Béla G. Lipták, Instrument Engineers' Handbook: Process control and optimization, ISA Press, 4th Edition.
E-References:	
1.	http://nptel.ac.in/courses/112104039/lecture13/13_8.html
2.	https://www.youtube.com/watch?v=7SAyVrgyCl4
3.	https://learn.ni.com/learn/article/labview-tutorial

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the architecture and interfaces of VI.	L2
CO2	Design and analyze various applications using signal Processing tool kit	L2
CO3	Understand the concepts of conditional operators of VI	L2
CO4	Create applications that uses plug in DAQ boards and built in analysis functions to process the data	L2
CO5	Apply structured programming concepts in developing VI programs and employ various debugging techniques.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	1	2	2	2	1				2	2	3	1	2
CO2	2	2	2	3	1	2	2				2	3	1	1	2
CO3	2	1	3	2	2	1	2				3	2	3	2	1
CO4	1	3	2	1	3	3	2				2	3	2	3	2
CO5	2	1	2	1	1	1	2				3	2	1	2	3
Avg	**1.6**	**1.8**	**2**	**1.8**	**1.8**	**1.8**	**1.8**	**0**	**0**	**0**	**2.4**	**2.4**	**2**	**1.8**	**2**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE706	MICRO ELECTROMECHANICAL SYSTEMS	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the basics of MEMS and mechanics for MEMS Design.
2	To get knowledge about the concepts of optical and RF MEMS and design of electrostatic.
3	To apply the basic knowledge of MEMS in different fields.

Unit I	INTRODUCTION TO MEMS	9	0	0	9

MEMS and Microsystems-Miniaturization-Typical products-Micro sensors-Micro actuation- MEMS with micro actuators-Micro accelerometers and Micro fluidics-MEMS materials-Microfabrication-Wafer-level processes – Pattern transfer.

Unit II	MECHANICS FOR MEMS DESIGN	9	0	0	9

Elasticity-Stress-strain and material properties-Bending of thin plates-Spring configurations -torsionaldeflection Mechanical vibration-Resonance-Thermo mechanics actuators-force and response time-Fracture and thin film mechanics**.**

Unit III	ELECTROSTATIC DESIGN AND SYSTEM ISSUES	9	0	0	9

Electrostatics: basic theory-electrostatic instability. Surface tension-gap and finger pullup-Electrostatic actuators-Comb generators- gap closers- rotary motors- inch worms-Electromagnetic actuators. bistable actuators. Electronic Interfaces-Feedback systems-Noise-Circuit and system issues.

Unit IV	MEMS APPLICATION	9	0	0	9

Case studies-Capacitive accelerometer-Piezo electric pressure sensor-Micro fluidics application-Modeling of MEMS systems-CAD for MEMS.

Unit V	INTRODUCTION TO OPTICAL AND RF MEMS	9	0	0	9

Optical MEMS—System design basics-Gaussian optics-matrix operations-resolution. Case studies-MEMS scanners and retinal scanning display-Digital Micro mirror devices.RF Memsdesign basics-case study Capacitive RF MEMS switch-performance issues.

Total (45+15) = 60 Periods

Text Books:

1	Stephen Santeria,“ Microsystems Design”,Kluwe publishers,2000.
2	N.P.Mahalik ,“MEMS”, Tata McGrawhill,2007

Reference Books:

1	Vijay. K.Varadan, K.J.Vinoy, K.A.Jose, “RF MEMS And Applications”, JohnWiley&Sons,2003.
2	Nadim Maluf, ”An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000. 3. Mohamed Gad-el-Hak, editor, ”The MEMS Handbook”,CRC press Baco Raton,2000.
3	TaiRanHsu, ”MEMS & Microsystems Design and Manufacture” Tata McGrawHill, NewDelhi, 2002. 5. Liu,”MEMS”,Pearson education,2007.
4	L.L. Faulkner, ‘Micro Electro Mechanical System Design’, Taylor & Francis Group, 2005.

E-References:	
1.	https://www.digimat.in/nptel/courses/video/117105082/L28.html
2.	https://nptel.ac.in/courses/108108113
3.	http://www.nitttrc.edu.in/nptel/courses/video/117105082/L14.html

Course Outcomes: Upon completion of this course, the students will be able to:		Bloom's Taxonomy Level
CO1	Knowledge on the basics of MEMS and mechanics for MEMS Design.	L2
CO2	Understand the electrostatic design	L2
CO3	Understand the concept of system issues and various applications of MEMS	L2
CO4	Ability to apply the basic knowledge of MEMS in different fields	L3
CO5	Exposure to concepts of optical and RF MEMS	L4

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3		2				2								
CO2	3	1	2	1											
CO3	2	1	2	1	3									1	
CO4	2		1	1	3		1	1			1			1	
CO5	2	1	1	1				1						2	1
Avg	3	0.6	1.6	0.8	1.2		0.6	0.4			0.2			0.8	0.2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE707	DEEP LEARNING	Semester			VII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To gain insights on machine learning basics and its challenges
2	To understand and apply deep learning algorithms using keras and Tensor flow
3	To perform object localization , pre-process data and use generative models

UNIT I	INTRODUCTION	9	0	0	9

Introduction to deep learning-Applied Math and Machine Learning Basics- Linear Algebra- Probability and Information Theory-Machine Learning Basics- Learning Algorithms- Capacity, Overfitting and Underfitting-Hyperparameters and Validation Sets-Supervised and Unsupervised Learning Algortihms- Challenges and Motivation for Deep learning

UNIT II	MODERN PRACTICAL DEEP NETWORKS	9	0	0	9

Deep Feed forward Networks- Regularization for Deep Learning- Optimization for Training Deep Models Challenges in Neural Network Optimization-Applications-Long Short Term Memory-Convolutional Neural Network (CNN) – Recurrent Neural Networks (RNN).

UNIT III	DEEP CONVOLUTIONAL MODELS	9	0	0	9

Object Detection: Object Localization, Landmark detection, YOLO Algorithm-NLP: Introduction to NLP and deep learning-Simple word vector representations: word2vec, GloVe-Advanced word vector representations- language models, softmax, single layer networks- Neural Networks and back propagation for named entity recognition

UNIT IV	GENERATIVE MODELS	9	0	0	9

Restrictive Boltzmann Machines (RBMs)- Introduction to MCMC and Gibbs Sampling- gradient computations in RBMs-Deep Boltzmann Machines Recent trends :Variational Auto encoders - Generative Adversarial Networks- Multi-task Deep Learning -Multi-view Deep Learning

Unit V	TOOLS AND APPLICATIONS	9	0	0	9

Introduction to Keras and Tensorflow-Deep learning for computer vision, Deep Learning Applications at the Enterprise Scale, Deep Learning Models for Healthcare Applications- Semantic parsing of Speech using Recurrent Net- LSTM network for sentiment analysis

Total(L+T)=45 Periods

Text Books:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2	Adam Gibson and Josh Patterson,”Deep Learning: A Practitioner's Approach”, 1st Edition,O’Reilly Media,2017

Reference Books:

1	Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013

2	Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.es of deep learning Technique
3	Miguel Morales, Grokking Deep Reinforcement Learning,2020
4	Stephan Raaijmakers,"Deep Learning for Natural Language Processing",Manning, 2022
E-References:	
1.	https://www.coursera.org/learn/convolutional-neural-networks
2.	http://neuralnetworksanddeeplearning.com/
3.	https://www.coursera.org/specializations/deep-learning

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Use deep learning algorithms for the specific use case.	L3
CO2	Practically implement deep networks for suitable real world problems using DL tools	L3
CO3	Perform object localization and efficiently pre-process data.	L2
CO4	Apply generative models and optimize on real world problems.	L3
CO5	Explore recent deep learning applications at Enterprise Scale and Healthcare.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2		2									2	1	2
CO2	2	3	3	2									2		2
CO3			2												2
CO4	2	2	2	2	2								3	2	2
CO5		2	2		2		2						3	2	2
Avg	1.2	1.8	1.8	1.2	0.8		0.4						2	1	2
3/2/1=indicates strength of correlation (3-High,2-Medium,1-Low)															

22PTECE801	MULTIMEDIA COMPRESSION AND COMMUNICATION TECHNIQUES	Semester			VIII
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
Basic mathematical analysis skills and digital modulation techniques.	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	Highlight the features of data redundancy and various compression techniques involved.
2	To understand the various challenges involved in text and audio compression.
3	To impart knowledge on various image and video compression techniques.

Unit I	**INTRODUCTION AND TEXT COMPRESSION**	**9**	**0**	**0**	**9**

Introduction: Overview of information theory - Redundancy – Compression Techniques: Loss less compression - Lossy Compression – Measures of performance–Text compression: Shannon Fano coding - Huffman coding – Arithmetic coding – Dictionary techniques – LZW family algorithms – Entropy measures of performance – Quality measures.

Unit II	**AUDIO COMPRESSION**	**9**	**0**	**0**	**9**

Introduction: Spectral masking, Temporal masking, Psychoacoustic model - Basic subbands coding - Application to speech coding: G.722 - Application to audio coding: MPEG audio - Progressive encoding for audio – Silence compression - Speech compression techniques– Vocoders.

Unit III	**IMAGE COMPRESSION AND VIDEO COMPRESSION**	**9**	**0**	**0**	**9**

Image compression: Predictive techniques – PCM – DPCM - DM - Transform coding - Introduction to JPEG - JPEG-2000 - JBIG standards - Study of EZW. Video compression: Video signal representation – ITU-T Recommendation H.261 – Model based coding – The MPEG-1 Video Standard - The MPEG-2 Video Standard: H.262- ITU-T Recommendation H.263.

Unit IV	**MULTIMEDIA COMMUNICATIONS**	**9**	**0**	**0**	**9**

Introduction – Multimedia networks: Telephone – Data – Broadcast television – ISDN – Broadband multiservice networks – Multimedia applications: Interpersonal communications – Interactive applications over the internet – Entertainment applications – Application and networking terminology: Media – Communication modes – Network – Multipoint conferencing – Network QoS – Application QoS.

Unit V	**STANDARDS FOR MULTIMEDIA COMMUNICATIONS**	**9**	**0**	**0**	**9**

Introduction – Reference models: TCP/IP- Protocol basics – Standards relating to interpersonal communications: Circuit mode networks - Packet switched networks - Electronic mail - Standards relating to interactive applications over the internet: Information browsing- Electronic commerce - Intermediate systems - Java and JavaScript – Standards for entertainment applications: Movie/Video on demand - Interactive television.

Total (45L+0T)= 45 Periods

Text Books:

1	SayoodKhaleed, - “Introduction to data compression”, Morgan Kauffman, London, 2006.
2	Fred Halshall - “Multimedia communication - Applications, Networks, Protocols and Standards”,Pearson Education, 2007.

Reference Books:	
1	Watkinson J, “Compression in video and audio”, Focal press, London,1995.
2	Mark Nelson, — “Data compression book”, BPB Publishers, New Delhi, 1998.
3	Jan Vozer, —Video compression for multimedia, AP 83rofess, New York, 1995
4	Peter D. Johnson Jr., Greg A. Harris, D.C. Hankerson, “Introduction to Information Theory and Data Compression”, 2nd Edition, Chapman and Hall/CRC, February 26, 2003.
E-References:	
1.	http://freevideolectures.com/Course/2278/Data-Communication/30
2.	http://nptel.ac.in/courses/106105082/30
3.	https://www.google.co.in/books/edition/Multimedia_Communications_Applications_N/g_lECYMqrVwC?hl=en&gbpv=1&dq=Fred+Halsall,+%E 2% 80% 95 Multimedia + communication- + Applications, +Networks, +Protocols+and+Standards%E2 %80 %96 ,+Pearson+education,+2007+pdf+ download & printsec = frontcover

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Understand different coding techniques and apply various algorithms for compression.	L2
CO2	Understand the quality and performance of various text and audio compression algorithms.	L2
CO3	Apply various text and video compression algorithms for practical applications.	L3
CO4	Apply the compression concepts in multimedia communication.	L3
CO5	Able to configure multimedia communication network.	L4

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	3	2								3	1	2
CO2	3	2	1	3	1								3	1	2
CO3	3	2	1	2	2								3	2	1
CO4	2	2	2	3	1								3	1	1
CO5	2	2	1	3	1								3	2	2
Avg	2.4	1.8	1.2	2.8	1.4								3	1.4	1.6
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE802	ADVANCED DIGITAL SIGNAL PROCESSING	Semester			VII
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
	Hours/Week	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	The course emphasizes an intuitive understanding of signal processing techniques.
2	Students will be able to represent FIR adaptive filters analytically and visualize them in the time domain.
3	Students will be able to specify and design any wavelet transform using MATLAB.

Unit I	**PARAMETRIC METHODS FOR POWER SPECTRUM ESTIMATION**	**9**	**0**	**0**	**9**

Relationship between the autocorrelation and the model parameters – The Yule-Walker method for the AR Model Parameters – The Burg Method for the AR Model parameters – unconstrained least-squares method for the AR Model parameters – sequential estimation methods for the AR Model parameters – selection of AR Model order.

Unit II	**ADAPTIVE SIGNAL PROCESSING**	**9**	**0**	**0**	**9**

FIR adaptive filters – steepest descent adaptive filter – LMS algorithm – convergence of LMS algorithms – Application: noise cancellation – channel equalization – adaptive recursive filters – recursive least squares.

Unit III	**MULTIRATE SIGNAL PROCESSING**	**9**	**0**	**0**	**9**

Decimation by a factor D – Interpolation by a factor I – Filter Design and implementation for sampling rate conversion: Direct form FIR filter structures – Polyphase filter structure.

Unit IV	**SPEECH SIGNAL PROCESSING**	**9**	**0**	**0**	**9**

Digital models for speech signal : Mechanism of speech production – model for vocal tract, radiation and excitation – complete model – time domain processing of speech signal:- Pitch period estimation – using autocorrelation function – Linear predictive Coding: Basic Principles – autocorrelation method – Durbin recursive solution.

Unit V	**WAVELET TRANSFORMS**	**9**	**0**	**0**	**9**

Fourier Transform : Its power and Limitations – Short Time Fourier Transform – The Gabor Transform - Discrete Time Fourier Transform and filter banks – Continuous Wavelet Transform – Wavelet Transform Ideal Case – Perfect Reconstruction Filter Banks and wavelets – Recursive multi-resolution decomposition – Haar Wavelet – Daubechies Wavelet.

Total(L+T)=45 Periods

Text Books:

1	John G.Proakis, Dimitris G.Manobakis, Digital Signal Processing, Principles, Algorithms and Applications, fourth edition, Pearson Education, 2012.
2	Monson H.Hayes –Statistical Digital Signal Processing and Modeling,Wiley,2008

Reference Books:

1	L.R.Rabiner and R.W.Schaber, Digital Processing of Speech Signals, Pearson Education (1979).

2	Roberto Crist, Modern Digital Signal Processing, Thomson Brooks/Cole (2004)
3	John M Yarbrough "Digital Logic applications and Design" Thomson Learning, 2001
4	S.K. Mithra, ―Digital Signal Processing: A computer based Approach‖, Tata McGraw Hill, New Delhi
E-References:	
1.	NPTEL : NOC:Digital Speech Processing (Electronics and Communication Engineering) (digimat.in)
2.	NPTEL :: Electrical Engineering - NOC:Multirate DSP
3.	NOC | Introduction to Time-Frequency Analysis and Wavelet Transforms (nptel.ac.in)

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the parametric methods for power spectrum estimation	L2, L4
CO2	Study about adaptive signal processing	L2, L4
CO3	Study the multi-rate signal processing	L2, L4
CO4	Study the speech signal processing	L2, L4
CO5	Study the fundamentals of wavelet transform.	L2, L4

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	1	1								2	2	2
CO2	3	2	2	2	1		1						2	2	2
CO3	3	2	2	2	1		1						2	2	2
CO4	3	2	2	2	1		1						2	2	2
CO5	1	1	1	1	1								2	2	2
Avg	2.6	2	1.2	1.2	1		0.6						2	2	2
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE803	BIO-MEDICAL ELECTRONICS	Semester	VIII
PREREQUISITES	Category	PE	Credit 3

	L	T	P	TH
Hours/Week	3	0	0	3

Course Learning Objectives

1	To gain knowledge about the various physiological parameters both electrical and non electrical, the methods of recording and also the method of transmitting these parameters.
2	To study about various assist devices used in hospitals.
3	To gain knowledge about equipment used for physical medicine and various recently developeddiagnostics and therapeutic techniques.

Unit I	**ELECTRO-PHYSIOLOGY AND BIOPOTENTIAL RECORDING**	**9**	**0**	**0**	**9**

The origin of Bio-potentials - Biopotential electrodes types - Bio amplifiers, ECG, EEG, EMG lead systems and recording methods, typical waveforms and signal characteristics.

Unit II	**BIO-CHEMICAL AND NON-ELECTRICAL PARAMETER MEASUREMENT**	**9**	**0**	**0**	**9**

Measurement of pH, PO2 and PCO2, colorimeter - Blood flow meter - Cardiac output - Respiratory rate measurement - Blood pressure measurement - Heart rate measurement - Pulse ratemeasurement - Blood cell counters.

Unit III	**MEDICAL IMAGING SYSTEM**	**9**	**0**	**0**	**9**

Radiography - Computer tomography – Mammography – Magnetic Resonance Imaging – Positron Emission Tomography - Ultrasonography - Thermography,

Unit IV	**ASSIST DEVICES AND BIO-TELEMETRY**	**9**	**0**	**0**	**9**

Cardiac pacemakers - DC Defibrillator – Hemodialyzer, Heart Lung Machine, Telemetry: principles, Frequency selection, Biotelemetry - Radio pill

Unit V	**RECENT TRENDS IN MEDICAL INSTRUMENTATION**	**9**	**0**	**0**	**9**

Endoscopy unit - Applications of Laser in medicine - Cryogenic application - Introduction to Telemedicine, Electrical safety in medical environment

Total (45+15) = 60 Periods

Text Books:

1	Khandpur, R.S., Handbook of Biomedical Instrumentation, TATA McGraw- Hill, New Delhi, 2014
2	John G. Webster, Medical Instrumentation Application and Design, John Wiley and Sons, 4th edn., 2009

Reference Books:

1	Joseph J.Carr and John M.Brown, Introduction to Biomedical equipment Technology, Pearson Education, 2013.
2	Leslie Cromwell, Fred J. Weibell, "Erich A. Pfeiffer, Biomedical Instrumentation and Measurements", Pearson Education India, 2nd Edition, 2015.

3	Edward J. Bukstein, Medical electronics, Ungar Publications, 2002
4	C.M. Smyth, Medical electronics, Iliffe Publication, 1999
E-References:	
1.	https://nptel.ac.in/courses/108108180
2.	https://biomedikal.in/2009/12/lecture-notes-on-biomedical-instrumentation/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Acquire and analyze the various bio signals and vital parameters.	L4
CO2	Measure biochemical and other physiological information.	L3
CO3	To understand the use of radiation for diagnostic and therapy	L2
CO4	Explain the function and application of various diagnostic and therapeutic equipment.	L2
CO5	Explain about the recent developments in the field of biomedical engineering and analyze the safety aspects of medical equipment.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1								3		2
CO2	3	2	2	1	2								3	1	2
CO3	3	1	3	1	1								3	1	2
CO4	3	2	2	1									3	2	1
CO5	3	2	3	1	1								3	2	2
Avg	3	1.8	2.4	1.2	1.2								3	1.2	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE804	RADAR AND NAVIGATIONAL AIDS	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To introduce the students about various types of radar and its applications.
2	To enhance the knowledge on detection of RADAR signals.
3	Develop the ability to learn Navigation and its systems.

UNIT I	RADAR AND RADAR EQUATION	9	0	0	9

Introduction to Radar: Basic Radar –The simple form of the Radar Equation- Radar Block Diagram- Radar Frequencies – Applications of Radar – The Origins of Radar -The Radar Equation**:** Introduction- Detection of Signals in Noise- Receiver Noise and the Signal-to-Noise Ratio-Probability Density Functions- Probabilities of Detection and False Alarm

UNIT II	MTI AND PULSE DOPPLER RADAR	9	0	0	9

Introduction to Doppler and MTI Radar- Delay –Line Cancellers- Staggered Pulse Repetition Frequencies –Doppler Filter Banks - Digital MTI Processing - Moving Target Detector - Limitations to MTI Performance - MTI from a Moving Platform (AMIT) - Pulse Doppler Radar – Tracking with Radar –Monopulse Tracking –Conical Scan and Sequential Lobing - Limitations to Tracking Accuracy - Low-Angle Tracking - Tracking in Range - Automatic Tracking with Surveillance Radars (ADT).

UNIT III	DETECTION OF SIGNALS AND RADAR COMMUNICATION	9	0	0	9

Detection of Signals in Noise: Introduction – Matched –Filter Receiver –Detection Criteria – Detectors -Automatic Detector - Integrators - Constant-False-Alarm Rate Receivers - The Radar operator - Signal Management - Propagation of Radar Waves - Atmospheric Refraction -Standard propagation - Nonstandard Propagation - The Radar Antenna - Reflector Antennas - Electronically Steered Phased Array Antennas - Phase Shifters - Frequency-Scan Arrays **Radar Transmitters**: Introduction – Linear Beam Power Tubes - Solid State RF Power Sources - Magnetron - Crossed Field Amplifiers - **Radar Receivers:** The Radar Receiver - Receiver noise Figure - Superheterodyne Receiver - Duplexers and Receiver Protectors- Radar Displays.

UNIT IV	FUNDAMENTALS OF NAVIGATION	9	0	0	9

Introduction: Introduction - Four methods of Navigation -Radio Direction Finding: The Loop Antenna - Loop Input Circuits - An Aural Null Direction Finder - The Goniometer - Errors in Direction Finding - Adcock Direction Finders - Direction Finding at Very High Frequencies - Automatic Direction Finders - The Commutated Aerial Direction Finder - Range and Accuracy of Direction Finders -Radio Range-Hyperbolic Systems of Navigation (Loran and Decca).

UNIT V	NAVIGATION SYSTEMS	9	0	0	9

DME and TACAN-Aids to Approach and Landing-Doppler Navigation- The Doppler Effect - Beam Configurations -Doppler Frequency Equations - Track Stabilization - Doppler Spectrum - Components of the Doppler Navigation System - Doppler range Equation - Accuracy of Doppler Navigation Systems-Inertial Navigation- Principles of Operation - Navigation Over the Earth - Components of an Inertial Navigation System - Earth Coordinate Mechanization - Strapped-Down Systems - Accuracy of Inertial Navigation Systems-Satellite Navigation System

Total(L+T)=45 Periods

Text Books:

1 Merrill I. Skolnik ," Introduction to Radar Systems", Tata McGraw-Hill (3rd Edition) 2008

2	N.S. Nagaraja, “Elements of Navigation Electronics”, 2nd edition, TMH,2006
Reference Books:	
1	Peyton Z. Peebles:, "Radar Principles", Johnwiley, 2004
2	Richards, Fundamentals of radar signal processing , 1st edition, tata mcgraw-hill education pvt. Ltd.
3	J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004.
4	Pritchard, satellite communication systems engineering , 2nd Edition Pearson Education Pvt. Ltd
E-References:	
1.	http://www.radioelectronics.com/info/data/semicond/semiconductor/semiconductor-materials-types-list.php.
2.	http://911electronic.com/
3.	https://nptel.ac.in/courses/108105154

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Gain knowledge in RADAR systems and analyze the signal to noise ratio in the radar system.	L3
CO2	Familiarize about MTI and pulse Doppler radar and detection of RADAR signals.	L2
CO3	Analyze the principle behind, detecting the signals of radar communication.	L3
CO4	Describe about the fundamentals of navigation.	L2
CO5	Explain the fundamentals of navigation systems.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1		1									1	2	1
CO2	2	1	1	1									1	2	1
CO3	2	1	1	1									1	2	1
CO4	2	1		1									1	2	1
CO5	2	1		1									1	2	1
Avg	2	1	0.4	1									1	2	1
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE805	WIRELESS SENSOR NETWORKS	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To obtain a broad understanding of the technologies and applications of wireless sensor networks
2	To design sensors used for wireless sensor networks
3	To understand the tools used for wireless sensor networks

UNIT-I	OVERVIEW AND ARCHITECTURES	9	0	0	9

Challenges for Wireless Sensor Networks - Applications of sensor networks - Difference between mobile ad-hoc and sensor networks, - Enabling Technologies for Wireless Sensor Networks. Single-Node Architecture: Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design principle of for WSNs.

UNIT-II	WSN NETWORKING CONCEPTS AND PROTOCOLS	9	0	0	9

Physical Layer and Transceiver Design Considerations in WSNs - MAC Protocols for Wireless Sensor Networks - Low Duty Cycle Protocols and Wakeup Concepts – Contention Based Protocols – Schedule Based Protocols - IEEE 802.15.4 MAC Protocol

UNIT-III	INFRASTRUCTURE ESTABLISHMENT	9	0	0	9

Time Synchronization: Introduction to the time synchronization problem - Protocols based on sender / receiver synchronization - Protocols based on receiver/ receiver synchronization - Localization and Positioning: Properties and possible approaches - single-hop localization – Positioning in multi-hop environments – Impact of anchor placement.

UNIT-IV	TOPOLOGY CONTROL	9	0	0	9

Motivation and basic ideas – Controlling topology in flat networks – power control – Hierarchical networks by dominating sets - Hierarchical networks by clustering – Combining hierarchical topologies and power control – Adaptive node activity.

UNIT-V	SENSOR NETWORK PLATFORMS AND TOOLS	9	0	0	9

Sensor Node Hardware: Berkeley Motes – Sensor network programming challenges, Node-level software platforms - Node-level Simulators - State-centric programming

Total (45+15) = 60 Periods

Text Books:

1	Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
2	Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

Reference Books:

1	Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-Technology, Protocols, And Applications”, John Wiley, 2007
2	Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

3	Bhaskar Krishnamachari, ”Networking Wireless Sensors”, Cambridge Press, 2005.
4	Mohammad Ilyas And Imad Mahgaob,”Handbook Of Sensor Networks: Compact Wireless And Wired Sensing Systems”, CRC Press, 2005.
E-References:	
1.	https://archive.nptel.ac.in/courses/106/105/106105160/
2.	https://www.digimat.in/nptel/courses/video/106105160/L01.html
3.	http://www.digimat.in/nptel/courses/video/106105160/L22.html

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Gain knowledge on some existing applications of wireless sensor networks.	L2
CO2	Get exposure to elements of distributed computing and network protocol design and will learn to apply these principles in the context of wireless sensor networks.	L3
CO3	Learn various hardware, software platforms that exist for sensor networks.	L2
CO4	Gain knowledge on the various topologies available in wireless sensor networks	L2
CO5	Do research problems in wireless sensor networks.	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2									2	2	2
CO2	3	1	1	1	1								2	2	2
CO3	2	2	3		2		1						3	1	2
CO4	2	2	2	2	1								1	2	1
CO5	2	2	3	3			1						3	2	2
Avg	2.4	1.8	2.2	1.6	0.8		0.4						2.2	1.8	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE806	NETWORK SECURITY	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand network security, architecture, and algorithms.
2	To study various encryption and decryption standards for network security.
3	To familiarize with necessary approaches and techniques to build protection mechanisms to secure computer networks.

Unit I	INTRODUCTION	9	0	0	9

Security Goals - Services, Mechanisms and attacks - OSI security architecture - Model of network security - Security trends - Legal, Ethical and Professional Aspects of Security - Need for Security at Multiple levels – Mathematics of Cryptography.

Unit II	SYMMETRIC CRYPTOGRAPHY	9	0	0	9

Encryption and Decryption – substitution techniques – transposition techniques - Block ciphers - Data Encryption Standard - Differential and Linear Cryptanalysis - Block Cipher model - Advanced Encryption Standard -Triple DES - RC5 - RC4 stream ciphers.

Unit III	PUBLIC KEY ENCRYPTION	9	0	0	9

Introduction to Number Theory - Public Key cryptography - Rivest-Shamir-Adleman Algorithm (RSA) - key management - Diffie-Hellman key exchange – Elliptic curve cryptography.

Unit IV	MESSAGE AUTHENTICATION AND INTEGRITY	9	0	0	9

Authentication requirements and functions – MAC – Hash functions – Security of hash functions and MAC – Secure Hash Algorithms – Digital signature and authentication protocols – Digital Signature Standard.

Unit V	NETWORK AND SYSTEM SECURITY	9	0	0	9

Authentication applications – E-mail Security – IP security – Web security – Intruders – malicious Software – Firewalls.

Total (45+15) = 60 Periods

Text Books:

1	William Stallings, "Cryptography and Network Security: Principles and Practice", PHI, 7th Edition, 2017.
2	Atul Kahate, "Cryptography and Network security", 4th ed, Tata McGraw-Hill, 2019.

Reference Books:

1	C K Shyamala, N Harini and Dr. T R Padmanabhan: Cryptography and Network Security, Wiley India Pvt.Ltd, 2011.
2	Behrouz A Forouson, "Cryptography & Network Security", 3rd ed, Tata McGraw hill, 2015.
3	Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Prentice Hall, 2nded, 2002.

4	Roberta Bragg, Mark Phodes-Ousley, Keith Strassberg,"Network Security: The Complete Reference", Tata Mcgraw-Hill, 2004.
E-References:	
1.	https://nptel.ac.in/courses/106105162
2.	https://nptel.ac.in/courses/106106178
3.	https://nptel.ac.in/courses/106105031

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the fundamentals of networks security, security architecture, threats and vulnerabilities	L2
CO2	Apply the different cryptographic operations of symmetric cryptographic algorithms.	L3
CO3	Acquire knowledge on the various public key cryptography techniques.	L2
CO4	Apply the various authentication schemes to simulate different applications.	L3
CO5	Understand various security practices and system security standards.	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	1	2		2	1					1		
CO2	3	2	2	2	2								2		1
CO3	3	2	2	2	2								1		
CO4	3	2	2	2	2								2	2	2
CO5	2	1	2	2	2	2	2	1					2	1	1
Avg	2	1.6	1.8	1.8	2	0.4	0.8	0.4					1.6	0.6	0.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE807	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	Semester	VIII

PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To understand the basics of EMI and EMC
2	To understand knowledge on the EMI coupling mechanism and its mitigation techniques
3	To understand comprehensive insight about the current EMC standards and about various measurement techniques

UNIT I	BASIC CONCEPTS	9	0	0	9

Definition of EMI and EMC- Intra and Inter system EMI- Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility- Transient EMI& ESD- Case Histories- Radiation Hazards to humans.

UNIT II	COUPLING MECHANISM	9	0	0	9

Common mode coupling- Differential mode coupling- Common impedance coupling- Ground loop coupling- Field to cable coupling- Cable to cable coupling- Power mains and Power supply coupling.

UNIT III	EMI MITIGATION TECHNIQUES	9	0	0	9

Shielding – principle, choice of materials for H, E and free space fields, and thickness- EMI gaskets; Bonding- Grounding – circuits, system and cable grounding; Filtering- Transient EMI control devices and applications- PCB Zoning, Component selection, mounting, trace routing.

UNIT IV	STANDARDS AND REGULATION	9	0	0	9

Units of EMI- National and International EMI Standardizing Organizations – IEC, ANSI, FCC, CISPR, BIS, CENELEC- FCC standards- EN Emission and Susceptibility standards and specifications- MIL461E Standards.

UNIT V	EMI TEST METHODS AND INSTRUMENTATION	9	0	0	9

EMI test sites - Open area site- TEM cell- Shielded chamber- Shielded Anechoic chamber- EMI test receivers- Spectrum Analyzer- Transient EMI Test wave Simulators- EMI coupling Networks - Line impedance Stabilization Networks- Feed through capacitors- Antennas and factors- Current probes and calibration factor- MIL-STD test methods- Civilian STD Test methods

Total(L+T)=45 Periods

Text Books:

1	V.P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, Newyork, 2001
2	Henry W.Ott., “Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988

Reference Books:

1	S.Janani, R.Ramesh Kumar, "Electro Magnetic Interference and Compatibility" Sruthi Publishers..
2	Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Ed, Artech house, Norwood, 1987.

3	Clayton R.Paul – Introduction to Electromagnetic compatibility – Wiley & Sons – 1992
4	Donwhite Consultant Incorporate – Handbook of EMI / EMC – Vol I – 1985

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Design an EMI free system	L3
CO2	Have Knowledge to reduce system level crosstalk	L2
CO3	Find solution to EMI Sources, EMI problems in PCB level / Subsystem and system level design.	L4
CO4	Design high speed printed circuit board with minimum interference	L3
CO5	Make our world free from unwanted electromagnetic environment	L3

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	2										3	3	2
CO2	2	2											2	1	2
CO3	3	2		2	1						1		2	1	2
CO4	2	1	1		1						2		3	1	1
CO5	2	2	2										3	2	2
Avg	2.2	1.6	1	0.4	0.4						0.6		2.6	1.6	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE808	MOBILE AD-HOC NETWORKS	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To make the students understand the concept of Mobile Ad-hoc Networks and various protocols used.
2	To obtain a knowledge on the security and energy management issues in Mobile Ad-hoc Networks.

Unit I	INTRODUCTION	9	0	0	9

Introduction to Ad Hoc networks – Definition, cellular Vs Ad Hoc networks – Applications of Ad Hoc wireless networks - Issues in Ad Hoc wireless networks - Ad hoc wireless internet.

Unit II	MEDIUM ACCESS PROTOCOLS	9	0	0	9

MAC Protocols: Design issues, goals and classification - Contention based protocols- Contention based protocols with reservation mechanisms - Contention based protocols with scheduling algorithms – MAC protocols that use directional antennas

Unit III	NETWORK PROTOCOLS	9	0	0	9

Routing Protocols: Design issues, classification - Table-driven routing protocols - On-demand routing protocols - Hybrid routing protocols - Hierarchical routing protocols - Power aware routing protocols.

Unit IV	END-TO-END DELIVERY AND SECURITY	9	0	0	9

Transport layer: Design issues, goals and classification - TCP over Ad Hoc wireless networks - Security in Ad Hoc wireless - Network security requirements - Issues and challenges – Network security attacks - Secure routing protocols

Unit V	ENERGY MANAGEMENT	9	0	0	9

Need for energy management - Classification of energy management schemes - Battery management schemes - Transmission power management schemes - System power management schemes.

Total (45+15) = 60 Periods

Text Books:

1	C.Siva Ram Murthy and B.S.Manoj, Ad hoc Wireless Networks Architectures and protocols, 2nd edition, Pearson Education. 2007
2	Charles E. Perkins, Ad hoc Networking, Addison – Wesley, 2000

Reference Books:

1	Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, Mobile ad hoc networking, Wiley-IEEE press, 2004.
2	Mohammad Ilyas, The handbook of adhoc wireless networks, CRC press, 2002.
3	Azzedine Boukerche, Algorithms and Protocols for Wireless and Mobile Ad Hoc Networks, John Wiley & Sons, 2009.

4	Jonathan Loo, Jaime Lloret Mauri, Jesus Hamilton Ortiz, Mobile Ad Hoc Networks current status and future trends, CRC Press, 2012.
E-References:	
1.	https://www.digimat.in/nptel/courses/video/106105160/L01.html
2.	http://www.nitttrc.edu.in/nptel/courses/video/106105160/L16.html
3.	https://archive.nptel.ac.in/courses/106/105/106105160/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the concept of Mobile Ad-hoc Networks.	L2
CO2	Describe the Medium Access protocols	L2
CO3	Analyze the network protocols	L4
CO4	Explain the concept of end to end delivery and security.	L2
CO5	Gain knowledge on the energy management schemes	L1

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	1									3	1	2
CO2	1	2	1	1	1								3	2	2
CO3	2	2	1	2									3	2	2
CO4	2	1	2	2	1								3	1	1
CO5	2	2	1	1									3	2	2
Avg	2	1.8	1.2	1.4	0.4								3	1.6	1.8
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE809	SPEECH PROCESSING	Semester			VIII
PREREQUISITES	**Category**	**PE**	**Credit**		**3**
Signal Processing and basic mathematical analysis skills.	**Hours/Week**	**L**	**T**	**P**	**TH**
		3	**0**	**0**	**3**

Course Learning Objectives

1	To understand the speech production mechanism and the various speech analysis techniques and speech models
2	To understand the speech compression techniques
3	To understand the speech recognition techniques
4	To have in depth knowledge on internetworking of WLAN and WWAN
5	To know the speaker recognition and text to speech synthesis techniques

Unit I	**SPEECH SIGNAL CHARACTERISTICS & ANALYSIS**	**9**	**0**	**0**	**9**

Speech production process - speech sounds and features- - Phonetic Representation of Speech --representing= speech in time and frequency domains - Short-Time Analysis of Speech - Short-Time Energy and Zero-Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception

Unit II	**SPEECH COMPRESSION**	**9**	**0**	**0**	**9**

Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation -Vector Quantization- Linear predictive coding (LPC) - Code excited Linear predictive Coding(CELP)

Unit III	**SPEECH RECOGNITION**	**9**	**0**	**0**	**9**

LPC for speech recognition- Hidden Markov Model (HMM)- training procedure for HMM- subword unit model based on HMM- language models for large vocabulary speech recognition – Over all recognition system based on subword units - Context dependent subword units- Semantic post processor for speech recognition

Unit IV	**SPEAKER RECOGNITION**	**9**	**0**	**0**	**9**

Acoustic parameters for speaker verification- Feature space for speaker recognition-similarity measures- Text dependent speaker verification-Text independent speaker verification techniques

Unit V	**SPEAKER RECOGNITION AND TEXT TO SPEECH SYNTHESIS**	**9**	**0**	**0**	**9**

Text to speech synthesis(TTS)-Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness-role of prosody

Total (45+15) = 60 Periods

Text Books:

1	L. R. Rabiner and R. W. Schafer, Introduction to Digital Signal Processing, Foundations and Trendsin Signal Processing Vol. 1, Nos. 1–2 (2007) 1–194
2	Ben Gold and Nelson Morgan “Speech and Audio signal processing- processing and perception of speech and music”, John Wiley and sons 2006

Reference Books:

1	Lawrence Rabiner, Biiing and– Hwang Juang and B.Yegnanarayana “Fundamentals of Speech Recognition”, Pearson Education, 2009
2	Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999
3	Donglos O shanhnessy “Speech Communication: Human and Machine “, 2nd Ed. Universitypress 2001
E-References:	
1.	http://www.digimat.in/nptel/courses/video/117105145/L37.html
2.	https://www.youtube.com/watch?v=rC16fhvXZOo
3.	https://nptel.ac.in/courses/117105145

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom’s Taxonomy Level**
CO1	Analyze the characteristics of speech signals	L2
CO2	Design speech compression techniques	L2
CO3	Configure speech recognition techniques	L2
CO4	Design speaker recognition systems	L2
CO5	Design text to speech synthesis systems	L2

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	-	1	2	1	1	-	-	-	3	1	2	1	2
CO2	2	2	-	1	2	2	2	-	-	-	3	1	3	2	1
CO3	1	1	-	1	1	2	1	-	-	-	3	1	3	2	1
CO4	2	2	-	1	2	2	2	-	-	-	3	1	2	2	2
CO5	1	1	-	1	2	1	1	-	-	-	3	1	3	1	1
Avg	**1.4**	**1.4**	**-**	**1**	**1.8**	**1.6**	**1.4**	**-**	**-**	**-**	**3**	**1**	**2.6**	**1.6**	**1.4**
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															

22PTECE810	SYSTEM ON CHIP DESIGN	Semester			VIII
PREREQUISITES	Category	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Learning Objectives

1	To know the Concepts and methodology of System on chip.
2	To design different methodology for logic cores, memory cores and analog cores.
3	Learn design validation and SOC testing.

Unit I	INTRODUCTION	9	0	0	9

System trade offs and evolution of ASIC Technology – System on chip concepts and methodology – SoC design issues – SoC challenges and components.

Unit II	DESIGN METHODOLOGY FOR LOGIC CORES	9	0	0	9

SoC Design Flow – On-chip buses – Design process for hard cores – Soft and firm cores – Designing with hard cores, soft cores – Core and SoC design examples.

Unit III	DESIGN METHODOLOGY FOR MEMORY AND ANALOG CORES	9	0	0	9

Embedded memories – Simulation modes – Specification of analog circuits – A to D converter – D to A converter – Phase-located loops – High speed I/O

Unit IV	DESIGN VALIDATION	9	0	0	9

Core level validation – Test benches- SoC design validation – Cosimulation – Hardware/software co-verification.

Unit V	SOC TESTING	9	0	0	9

SoC Test issues – Testing of digital logic cores – Cores with boundary scan – Test methodology for design resuse – Testing of microprocessor cores – Built in self test method.

Total(L+T)=45 Periods

Text Books:

1	RochitRajsuman, “System-on-a-chip: Design and Test”, Artech House, London, 2000.
2	Laung-Terng Wang, Charles E Stroud and Nur A Toubq, “System on Chip Test Architectures: Nanometer Design for Testability”, Morgan Kaufmann, 2008

Reference Books:

1	WgelBadawy, Graham A Jullien, “System-on-Chip for Real-Time Applications”, Kluwer Academic Press, 2003.
2	Rajanish K Kamat, Santosh A Shinde, Vinod G Shelake, “Unleesh the System-on-Chip using FPGAs and Handle C, Spinger 2009.
3	Steve Furber, “ARM System on Chip Architecture”, 2nd Edition, Addison- Wesley Professional , Aug 2000

4	Ricardo Reis, "Design of System on a Chip: Devices and Components" Springer 1st Edition, July 2004
E-References:	
1.	https://nptel.ac.in/courses/108102045/10
2.	https://freevideolectures.com/course/2341/embedded-systems/10
3.	https://www.elprocus.com/difference-between-soc-system-on-chip-single-board-computer/

Course Outcomes: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Level**
CO1	Understand the Concepts and methodology of System on chip.	L2
CO2	Design different methodology for logic cores.	L4
CO3	Design different methodology for memory and analog cores	L4
CO4	Design SoC validation CO5: Test different logic cores.	L3
CO5	Test different logic cores.	L5

COURSE ARTICULATION MATRIX

COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1		2	2	2							1		1	2	1
CO2		2	2	3							2		1	2	1
CO3		2	3	3									2	1	2
CO4		2	3	3							2		2	1	2
CO5		2	3	3							1		1	2	1
Avg		2	2.6	2.8							1.2		1.4	1.6	1.4
3/2/1 – indicates strength of **correlation (3- High, 2- Medium, 1- Low)**															