NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

CURRICULUM

OF

BACHELOR OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATION ENGINEERING

2021 ONWARD UNDERGRADUATE ADMISSION BATCH

V0:

Resolution of 50th Senate	18-05-2018	Item no: 50.7
Resolution of 51st Senate	04-10-2018	Item no: 51.2
Resolution of UGAC meeting	10-05-2019	
Final approval in 53rd Senate	13-05-2019	Item no: 52.3
Publication date	30-05-2019	

V1:

Incorporation of new elective subjects	27-06-2019

V2:

Rectification of minor errors	UGAC 31-08-2022

Final Approval in 67th Senate dated 20/09/2022 vide Item no: # 67.3

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Program Name: Bachelor of Technology in Electronics and Communication Engineering

DETAILED CURRICULUM

CURRICULUM OF 2021 ONWARD UNDERGRADUATE ADMISSION BATCH FOR ELECTRONICS AND COMMUNICATION ENGINEERING - B.TECH.

L= Lecture hour/ week; T= Tutorial hour/ week; S= Sessional/ practical hour/ week

C= Subject credit point; H= Subject contact hour/ week.

Semester - I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31
Semester - II							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

Semester - III		

Sl.	Code	Subject	L	T	S	C	H
1	MAC331	Mathematics - III	3	1	0	4	4
2	ECC301	Network Analysis and Synthesis	3	1	0	4	4
3	ECC302	Electronic Devices and Circuits- I	3	1	0	4	4
4	ECC303	Signals and Systems	3	0	0	3	3
5	PHC331	Physics of Semiconductor Devices	3	0	0	3	3
6	PHS381	Semiconductor Devices Laboratory	0	0	3	1.5	3
7	ECS351	Network Analysis and Synthesis Laboratory	0	0	3	1.5	3
8	ECS352	Electronic Devices and Circuits Laboratory	0	0	3	1.5	3
9	XXS381	Co-curricular Activities - III (Optional)	0	0	0	0	0
		TOTAL	15	3	9	22.5	27
Semester - IV							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	ECC401	Analog Communication	3	1	0	4	4
2	ECC402	Digital Circuits and Systems	3	1	0	4	4
3	ECC403	Electromagnetic Theory and Transmission Lines	3	1	0	4	4
4	EEC431	Control Systems	3	0	0	3	3
5	YYO44*	Open Elective - I	3	0	0	3	3
6	ECS451	Analog Communication Laboratory	0	0	3	1.5	3
7	ECS452	Digital Circuits and Systems Laboratory	0	0	3	1.5	3
8	EES481	Control Systems Laboratory	0	0	3	1.5	3
9	XXS481	Co-curricular Activities - IV (Optional)	0	0	0	0	0
		TOTAL	15	3	9	22.5	26
Semester - V							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	ECC501	Digital Communication	3	1	0	4	4
2	ECC502	Microwave Engineering	2	1	0	3	3
3	ECC503	Microprocessors and Microcontrollers	3	1	0	4	4
4	ECC504	Electronic Devices and Circuits-II	3	1	0	4	4
5	YYO54*	Open Elective - 2	3	0	0	3	3
6	ECS551	Digital Communication Laboratory	0	0	3	1.5	3
7	ECS552	Microwave Engineering Laboratory	0	0	3	1.5	3
8	ECS553	Microprocessors and Microcontrollers Laboratory	0	0	3	1.5	3
9	XXS581	Co-curricular Activities - V (Optional)	0	0	0	0	0
		TOTAL	15	4	9	22.5	27

Semester - VI							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	HSC631	Economics and Management Accountancy	3	0	0	3	3
2	ECC601	Antenna and Wave Propagation	3	0	0	3	3
3	ECC602	VLSI Design	3	0	0	3	3
4	ECC603	Digital Signal Processing	3	1	0	4	4
5	ECE610 --	Depth Elective - 1	3	0	0	3	3
6	ECE610 --	Depth Elective - 2	3	0	0	3	3
7	ECS651	Antenna and Wave Propagation Laboratory	0	0	3	1.5	3
8	ECS652	VLSI Design Laboratory	0	0	3	1.5	3
9	ECS653	Digital Signal Processing Laboratory	0	0	3	1.5	3
10	XXS681	Co-curricular Activities - VI (Optional)	0	0	0	0	0
		TOTAL	18	1	9	23.5	28
Semester - VII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MSC731	Principles of Management	3	0	0	3	3
2	ECE710 --	Depth Elective - 3	3	0	0	3	3
3	ECE710 --	Depth Elective - 4	3	0	0	3	3
4	ECE710 --	Depth Elective - 5	3	0	0	3	3
5	YYO74*	Open Elective - 3	3	0	0	3	3
6	ECS751	Computer Aided Design Laboratory	0	0	3	1.5	3
7	ECS752	Electronic System Design Laboratory	0	0	4	2	4
8	ECS753	Advanced Communication Laboratory	0	0	3	1.5	3
9	ECS754	Vocational Training / Summer Internship and Seminar	0	0	2	1	2
10	ECS755	Project - I	0	0	3	1	3
		TOTAL	15	0	15	22	30
Semester - VIII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	ECE810 --	Depth Elective - 6	3	0	0	3	3
2	YYO84*	Open Elective - 4	3	0	0	3	3
3	YYO85*	Open Elective - 5	3	0	0	3	3
4	ECS851	Project - II	0	0	15	5	15
5	ECS852	Project Seminar	0	0	0	1	0
6	ECS853	Comprehensive Viva Voce	0	0	0	1	0
		TOTAL	9	0	15	16	24

CREDIT UNIT OF THE PROGRAM:

Semester	**I + II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**TOTAL**
Credit Unit	45	22.5	22.5	22.5	23.5	22	16	174

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT.

6th Semester

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING	
ECE610	Artificial Intelligence & Soft Computing
ECE611	Computer Organization and Architecture
ECE612	Advanced Digital Communication
ECE613	Object Oriented Programming
ECE614	ASIC Design using Verilog/VHDL
ECE615	Active Filter Design
ECE616	VLSI Technology
ECE617	Probability and Random Signal Theory
ECE618	Data Comm. & Computer Networks
ECE619	Mobile Computing
ECE620	Nanoelectronics
ECE621	Measurement & Instrumentation
ECE622	Digital IC Design
ECE623	Mechatronics Systems
ECE624	Power Electronics
ECE625	Optical Communication

7th Semester

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING	
ECE710	Detection and Estimation Theory
ECE711	Information Theory & Coding
ECE712	Analog IC Design
ECE713	FPGA Based Design
ECE714	MEMS and Microsystems Technology
ECE715	Machine Learning
ECE716	Millimetre Wave Technology
ECE717	RF ID Technology and Applications
ECE718	VLSI System Design
ECE719	Telecommunication Networks
ECE720	Advanced Semiconductor Devices
ECE721	Random Processes
ECE722	Microwave Circuits & Techniques
ECE723	Semiconductor Device Modelling
ECE724	Biomedical Instrumentation
ECE725	Adhoc and Sensor Networks

8th Semester

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING	
ECE810	Wireless Communication
ECE811	Mixed Signal IC Design
ECE812	Broadband Communication

ECE813	Digital Image Processing
ECE814	Error Control Coding
ECE815	Embedded System Design
ECE816	RF and MMIC
ECE817	Design with Op. Amps. & Analog Integrated Circuits
ECE818	Satellite Communication
ECE819	RF IC Design
ECE820	Low Power Circuits & Systems
ECE821	Advanced Antenna Synthesis
ECE822	DSP Architectures in VLSI
ECE823	Internet of Things (IoT) Technology
ECE824	VLSI Testing and Verification
ECE825	Statistical Signal Processing

DETAILED SYLLABUS
FIRST SEMESTER

Semester - I							
Sl. No	Code	Subject	L	T	S	C	H
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MAC 01</td><td>MATHEMATICS - I</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic concepts of function, limit, differentiation, and integration.</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: To introduce the fundamentals of differential calculus of single and several variables
• CO2: To develop the basic concepts of integral calculus including multiple integrals and its application in finding area, volume, centre of mass, centre of gravity etc.
• CO3: To introduce the fundamental concepts of vector calculus
• CO4: To develop the concept of convergence</td></tr>
</table>

Topics Covered	**Functions of Single Variable:** Rolle's Theorem and Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's and Maclaurin's series, Asymptotes & Curvature (Cartesian, Polar form). (8) **Functions of several variables:** Function of two variables, Limit, Continuity and Differentiability, Partial derivatives, Partial derivatives of implicit function, Homogeneous function, Euler's theorem and its converse, Exact differential, Jacobian, Taylor's & Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof), Stationary points, Lagrange's method of multipliers. (10) **Sequences and Series:** Sequences, Limit of a Sequence and its properties, Series of positive terms, Necessary condition for convergence, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Mean value theorems of integral calculus, Improper integral and it classifications, Beta and Gamma functions, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms. (12) **Multiple Integrals:** Double integrals, Evaluation of double integrals, Evaluation of triple integrals, change of order of integration, Change of variables, Area and volume by double integration, Volume as a triple integral. (10) **Vector Calculus:** Vector valued functions and its differentiability, Line integral, Surface integral, Volume integral, Gradient, Curl, Divergence, Green's theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their applications. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10th ed., Wiley India Ed. (2010). 2. Daniel A. Murray, Differential, and Integral Calculus, Fb & c Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11th Ed., Addison Wesley.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC01	CO1	2	3	2	3	1	1	-	-	1	1	1	2
	CO2	2	3	2	3	-	1	-	-	1	1	2	2
	CO3	2	3	2	3	-	1	1	-	-	2	2	2
	CO4	3	3	2	3	1	1	-	1	-	2	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC01	**Engineering Physics**	**PCR**	**2**	**1**	**0**	**3**	**3**
Pre-requisites:		Course Assessment methods: (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	CO1: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems. CO2: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. CO3: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. CO4: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.						
Topics Covered	**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and forced vibrations, Equation of motion, Amplitude resonance, Velocity resonance, Quality factor, sharpness of resonance, etc. [8] **Wave Motion** - Wave equation, Longitudinal waves, Transverse waves, Electro-magnetic waves. [3] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis of polarized lights. [5] **Laser and Optical Fiber** - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5]						
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. A Text Book of Oscillations and Waves, M. Goswami and S. Sahoo, Scitech Publications 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**:						

	1. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 2. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 3. Fundamental of Optics, Jankins and White, McGraw-Hill 4. Optics, A. K. Ghatak, Tata McGraw-Hill 5. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 6. Lasers and Non-linear Optics, B. B. Laud , New Age International Pvt Lt

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC01	CO1	3	2	1	1	1	-	-	1	-	-	-	1
	CO2	3	2	-	2	-	-	-	-	-	-	-	1
	CO3	3	2	2	2	1	1	1	1	1	-	1	1
	CO4	3	2	2	2	1	1	1	-	1	-	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 01	Engineering Chemistry	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes	• CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption, and catalytic processes for engineering applications • CO2: To learn fundamentals of polymer chemistry and petroleum engineering. • CO3: Introduced to basic spectroscopic techniques for structure determination and characterization. • CO4: To study few inorganic and bioinorganic compounds of industrial importance.						
Topics Covered	**ORGANIC CHEMISTRY** i. Fundamentals of organic reaction mechanisms; Few important reactions and their mechanism along with their applications; Robinson annulation, Hydroboration reaction, Organometallic reagents (Gilman reagents), Metathesis using Grubb's catalyst and Wittig reaction. (3) ii. Fundamental concept on stereochemistry and application: Conformation and configuration of organic compounds, Diastereo-selective, enantio-selective, regio-selective, stereo-specific, and stereo-selective reactions. (3) iii. Polymer chemistry and polymer engineering: Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber, and plastic materials. Conducting polymer. (2) iv. Petroleum Engineering and oil refinery: origin of mineral oils, separation principle and techniques of distillation of crude oil, Uses of different fractions, octane number, cetane number, Knocking, anti-knock compounds, and Bio-Fuel.						

	(2) v. Structure elucidation of organic compounds by modern spectroscopic methods; Application of UV-Visible and FT-IR spectroscopy. (3) **INORGANIC CHEMISTRY** i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, Jahn-Teller distortion, pseudo Jahn-Teller distortion, Isomerism, and stereochemistry. (5) ii. **Bioinorganic Chemistry:** Heme and non-heme O_2 transport protein (Haemoglobin, Myoglobin), Chlorophyll and photosynthesis. (3) iii. **Inorganic Materials:** Introduction towards industrially important inorganic materials like cementing material, refractory material, fertiliser, inorganic polymer. (2) iv. **Organometallic Chemistry:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes. (4) **PHYSICAL CHEMISTRY** i. **Thermodynamics:** 2nd law of thermodynamics, entropy, free energy, Gibbs Helmholtz equation, change of phase. Cryogenics: joule Thomson experiment. (4) ii. **Chemical Kinetics:** 2nd and 3rd order rate expression, Reversible reaction, Chain reaction, Consecutive reaction, Temp effect on reaction rate. (4) iii. **Electrochemistry:** Electrochemical cell, Effect of pH, precipitation, and complex formation on EMF of oxidation/reduction processes. (2) iv. **Absorption:** Physical and Chemical absorption, Absorption isotherms. (1) v. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis. (2)
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press (ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYC 01	CO1	1	2	-	-	-	-	-	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	1	2	1	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	-	2	-	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
XEC01	**ENGINEERING MECHANICS**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	• CO1: Acquire knowledge of mechanics and ability to draw free body diagrams. • CO2: Apply knowledge of mechanics for solving special problems like truss and frame analysis. • CO3: Ability to calculate centroid, moments of inertia for various shapes. • CO4: Learn momentum and energy principles. • CO5: Knowledge on virtual Work Principle and its application						
Topics Covered	Engineering Mechanics; measurement and SI units. [1] Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2] Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to different types of constraints; simple space problems of rigid bodies. [4] Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5] Simple trusses; analysis of trusses by method of joints and method of sections. [5] Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4] Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6] Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12] Principle of Virtual Work, Solution of Problems on Mechanics using Principle of Virtual Work [3]						

Text Books, and/or reference material	1) S P Timoshenko and D H Young, Engineering Mechanics, 5th Edition 2) J L Meriam and L G Kraige, Engineering Mechanics, 5th Edition, Wiley India 3) F P Beer and E R Johnston, Vector Mechanics for Engineers 4) I H Shames, Engineering Mechanics

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC01	CO1	1	-	-	-	-	-	-	-	-	-	-	1
	CO2	1	1	1	1	-	-	-	-	-	-	-	1
	CO3	1	1	-	-	-	-	-	-	-	-	-	1
	CO4	1	2	-	-	-	-	-	-	-	-	-	1
	CO5	-	2	2	2	2	1	-	-	-	1	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
ESC01	**Environmental Science**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	• CO1: Understand the importance of environment and ecosystem. • CO2: Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. • CO3: Understand the scientific basis of local and as well as global issues. • CO4: Apply of knowledge to develop sustainable solution.						
Topics Covered	**Introduction:** Multidisciplinary nature of Environmental Studies; Basic issues in Environmental Studies. [2] Human population and the Environment. [1] Social issues and the Environment. [1] **Constituents of our Environment & the Natural Resources:** Atmosphere– its layers, their characters; Global warming, Ozone depletion, Acid rain, etc. [5] Hydrosphere - Its constituents, Oceans, Groundwater, Surface waters; Hydrological cycle. [4] Lithosphere - constituents of lithosphere; Rock and Mineral resources; Plate Tectonic Concept and its importance. [5] Biosphere– its components; Ecosystems and Ecology; Biodiversity; Biomes. [5] Natural disaster and their management – Earthquakes, Floods, Landslides, Cyclones. [3] **Pollution:** Pollutants and their role in air and water pollution. [2]						

Text Books, and/or reference material	1. Environmental Studies – Benny Joseph – Tata McgrawHill-2005 2.Environmental Studies – Dr. D.L. Manjunath, Pearson Education-2006. 3.Principles of Environmental Science and Engineering – P. V. Rao, PHI. 4. Environmental Science and Engineering – Meenakshi, Prentice Hall India. 5.Environmental studies – R. Rajagopalan – Oxford Publication - 2005. 6. Text book of Environmental Science & Technology – M. A. Reddy – BS Pub.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ESC01	CO1	3	-	-	-	-	-	2	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	2	-	-	-	-	-	2	-	-	-	-	-
	CO4	1	-	3	-	-	2	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**ENGINEERING GRAPHICS**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Ability of mental visualization of different objects • CO2: Theoretical knowledge of orthographic projection to solve problems on one/two/three dimensional objects • CO3: Able to read/interpret industrial drawing and to communicate with relevant people						
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1st, 2nd, 3rd and 4th quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3]						

	Freehand graphics. [3]
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… Engineering Drawing – N D Bhat 3)… Practical Geometry and Engineering Graphics – W Abbott

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES51	CO1	1	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	1	-	-	-	-	-	-	-	-	-	-
	CO3	1	-	1	-	-	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSS51	Professional Communication Lab	PCR	1	0	2	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: Improvement in linguistic proficiency of the learners • CO2: Improvement in communicative ability of the learners • CO3: Improvement in social connectivity skill						
Topics Covered	1. Professional Communication: Introduction (1) 2. Technical Writing: Basic Concepts (2) 3. Style in Technical Writing (3) 4. Technical Report (2) 5. Recommendation Report (2) 6. Progress Report (1) 7. Technical Proposal (3) 8. Business Letters (3) 9. Letters of Job Application (2) 10. Writing Scientific and Engineering Papers (3) 11. Effective Use of Graphic Aids (2) 12. Presentation Techniques (6) 13. Group Discussion (6) 14. Interview Techniques (6)						
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana& Savitha (Cambridge UP) **Reference Books:** 1. English for Engineers -Sudharshana & Savitha (Cambridge UP) 2. Effective Technical Communication-M A Rizvi (McGraw Hill Education)						

	3. References to relevant NPTEL, MOOC, SWAYAM courses be given by the Instructor

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSS51	CO1	1	_	_	1	_	1	_	1	2	3	1	_
	CO2	1	_	_	1	_	2	_	2	2	3	2	_
	CO3	_	_	_	1	_	3	_	3	3	3	2	_

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHS51	Physics Laboratory	PCR	0	0	2	2	1

Pre-requisites	Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))
NIL	CE+EA
Course Outcomes	CO1: To realize and apply different techniques for measuring refractive indices of different materials. CO2: To realize different types of waveforms in electrical signals using CRO. CO3: To understand charging and discharging mechanism of a capacitor. CO4: To understand interference, diffraction and polarization related optical phenomena. CO5: To acquire basic knowledge of light propagation through fibers.
Topics Covered	1. Find the refractive index of a liquid by a travelling microscope. 2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster's law/Malus' law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton's ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.
Text and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Mazumdar and B. Ghosh 2) Practical Physics – Worsnop and Flint

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHS51	CO1	3	2	1	-	-	-	-	-	2	1	-	1
	CO2	3	2	1	-	-	1	-	-	2	1	-	1
	CO3	3	1	-	-	-	-	-	-	2	1	-	1
	CO4	3	2	-	1	-	1	1	-	2	1	-	1
	CO5	3	2	1	-	1	1	1	-	2	1	-	1

Correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn basic analytical techniques useful for engg applications. • CO2: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. • CO3: Learn chromatographic separation methods. • CO4: Applications of spectroscopic measurements.						
Topics Covered	i. Experiments based on pH metry: Determination of dissociation constant of we acids by pH meter. ii. Experiments based on conductivity measurement: Determination of amou of HCl by conductometric titration with NaOH. iii. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry iv. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, Fe(acac cis-bis(glycinato)copper (II) monohydrate and their characterization by m. p FTIR etc. vi. Synthesis and charact. of organic compounds: e.g.Dibenzylideneacetone. vii. Synthesis of polymer: polymethylmethacrylate viii. Verification of Beer-Lamberts law and determination of amount of iron prese in a supplied solution. ix. Chromatography: Separation of two amino acids by paper chromatography x. Determination of saponification value of fat/ vegetable oil						
	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu&Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYS51	CO1	2	1	-	1	-	-	-	-	-	-	-	-
	CO2	-	1	-	1	1	2	-	-	-	-	-	-
	CO3	2	-	-	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	1	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
WSS51	**WORKSHOP PRACTICE**	PCR	**0**	**0**	**3**	**3**	**1.5**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes

- CO1: Study and practice on machine tools and their operations
- CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
- CO3: Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
- CO4: Develop basic electrical engineering knowledge for house wiring practice

Topics Covered

M/c shop & Carpentry shop -- 3X3= 9hrs.

- Introduction on machining process.
- Introduction to machine tools- Lathe, Shaper, Milling and Drill machine.
- Introduction to woods- Types, structure, disease and defect of wood.
- Introduction to wood working machines and tools.
- Making of dovetail joint and bridle joint.

Welding Shop & Sheet metal -- 3X3= 9hrs.

- Introduction to welding.Safety and precautions in welding.
- Formation of weld bead by SMAW on mild steel flat.
- Formation of weld bead by oxy-fuel welding on mild steel flat.
- Introduction to sheet Metal works.
- Tools and Machines used in sheet metal works.
- Concept of development, marking out of metal sheets.
- Cutting and joining of metal sheets.
- Safety precautions, General warning needed in the shop floor.

Black smithy & Foundry -- 3X3= 9hrs.

- Introduction Smithing and Forging- Tools, Machines, Furnaces and its accessories, fuels.
- Safety and precautions in blacksmithy.
- Making of bars of different cross-sections.
- Making of hexagonal headed bolts.
- Forge welding.
- Introduction to Foundry Technology.
- Preparation of sand mould using Solid/Split Pattern.

Fitting & Electrical shop -- 3X3= 9hrs.

- Introduction to hand metal cutting tools with specifications, nomenclature and their use.
- Marking tools, measuring tools and their use.
- Fitting of joints of mild steel flats.
- Introduction to electrical hazards and safety precaution.

	• Wire jointing and soldering. • PVC Conduit Wiring controlled by separate single way switches. • PVC Cashing Capping Wiring for two-way switches. • Conduit wiring for the connection of a Calling Bell with In& Out Indicators. • Batten Wiring and Cleat Wiring. • Tube Light Connection. • Insulation Resistance Testing of 1ph / 3ph Motor and House Wiring. • Earth Resistance Testing. • DOL Starter Connection. **Viva voce -- 1X3= 3hrs.**
Text Books, and/or reference material	1. Workshop Technology Part I and Part II by W. A. J. Chapman 2. Elements of Workshop Technology S. K. Hazra Chowdhury, A. K. Hazra Chowdhury and Nirjhar Roy 3. Mechanical Workshop Practice by K. C. John

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
WSS51	CO1	2	-	-	-	-	1	-	-	-	1	-	-
	CO2	1	-	1	-	-	1	-	-	-	1	-	-
	CO3	1	-	2	-	-	1	-	-	-	1	-	-
	CO4	1	-	-	-	-	2	-	-	-	1	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXS-51	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
NIL	CT+EA

Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service

Topics Covered	**YOGA** • Introduction of Yoga. • Sitting Posture/Asanas- Padmasana, Vajrasana, Ardhakurmasana, Ustrasana, Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar. • Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra. • Laying Posture/Asanas- PavanaMuktasana, UttanaPadasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani. • Meditation- Yognidra, Om chant, Pray chant. • Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardhachandrasana, Trikonasana, Utkatasana, Padahastasana. • Pranayama- Deep breathing, AnulomVilom, Suryabhedi, Chandrabhedi. • Kriya- Kapalbhati, Trataka. **ATHLETICS** • Introduction of Athletic. • Starting Technique for Track events- Standing start, Crouch & Block start. • Finishing Techniques. • Relay Race- 4×100m, 4×400m & Baton Exchange Technique & Rules. • Track Marking with Fundamentals- 200m, 400m and Diagonal Distance Radius, Straight Distance, Staggers of Different Lanes & Curve Distance. **BASKETBALL** • Introduction and Players stance and ball handling. • Passing- Two hand chest pass, two hand bounce pass, One hand baseball pass, Side arm pass, Overhead pass, Hook pass. • Receiving- Two hand receiving, one hand receiving, receiving in stationary position, Receiving while jumping and Receiving while running. • Dribbling- Dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Introduction of Volleyball • Service- Underarm service, Sidearm service, Tennis service, Floating service, Jump service. • Pass: Underarm pass- Ready position, Teaching stage of underarm pass and Upper hand pass- Volley pass, Back pass, Short set, Jump set & Underarm set. • Rules and their interpretation. **FOOTBALL** • Introduction of Football • Push pass- Instep inside, Instep outer side.

	• Kicking- Spot kick, Instep kick, Lofted kick. • Dribbling- One leg, Both legs, Instep. • Trapping- Rolling ball sole trapping, High ball sole trapping, High ball chest trapping, High ball thigh trapping. • Throwing- Standing throw, Running throw, Seating throw. • Goal Keeping- Griping the ball, Full volley, Half volley, Drop Kick. • Rules and their interpretation. **CRICKET** • Introduction of Cricket • Batting gripping & Stance, Bowling gripping technique. • Batting front foot defense& Drive. • Batting Back foot defense& Drive. • Batting Square cut. • Bowling medium pace, Bowling off break. • Fielding drill, Catching (Short & High). • Rules & Regulation. **BADMINTON** • Basic introduction about Badminton and Badminton court. • Racket parts, Racket Grip, Shuttle Grip. • Basic stance, Basic Footwork, Shadow practice (Full court movement). • Strokes services: Forehand- Overhead & Underarm, Backhand- Overhead & Underarm. • Match practice (Single & Double). • Rules & Regulation. **TABLE TENNIS** • Introduction of Table Tennis. • Basic Stance and Grip (Shake hand & Pen hold). • Service Basic. • Stroke: Backhand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Stroke: Forehand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-1 General Introduction and words of command. • FD-2 Attention, Stand at ease and Stand easy, Turning and inclining at the halt. • FD-3 Sizing, Forming up in three Ranks Numbering, Open and Close order March and Dressing. • FD-4 Saluting at the halt, Getting on parade, Dismissing and falling out. • FD-5 Marching, Length of pace and Time of Marching in quick time and Halt,

	Slow March and Halt. • FD-7 Turning on the March and Wheeling. • FD-12 Parade practice. **TAEKWONDO** • Introduction about Taekwondo- Meaning of Taekwondo, Korean language of dress, Fighting area, Punch, Block, Kicks etc. • Stance- Ready stance, Walking stance, Fighting stance, Front stance, Back stance, Cat stance etc. • Punch Technique- Front fist punch, Rear fist punch, Double fist punch, With stance etc. Blocks- Upper blocks, Middle block, Side block, Suto etc. • Foot Technique (Balgisul)- Standing kick (Saseochagi), Front kick (Abchagi), Doliyo (Chagi), Abdalchagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus. • Unnat Bharat Abhiyaan • MatribhashaSaptah celebration

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS51	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SECOND SEMESTER

Sl. No	Code	Subject	L	T	S	C	H
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	The Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC 02</td><td>MATHEMATICS - II</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic concepts of set theory, differential equations, and probability.</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Develop the concept of basic linear algebra and matrix equations so as to apply mathematical methods involving arithmetic, algebra, geometry to solve problems.
• CO2: To acquire the basic concepts required to understand, construct, solve and interpret differential equations.
• CO3: Develop the concepts of Laplace transformation & Fourier transformation with its property to solve ordinary differential equations with given boundary conditions which are helpful in all engineering & research work.
• CO4: To grasp the basic concepts of probability theory.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Elementary algebraic structures: Group, subgroup, ring, subring, integral domain, and field. (5)
Linear Algebra: Vector space, Subspaces, Linear dependence and independence of vectors, Linear span, Basis and dimension of a vector space. Rank of a matrix, Elementary transformations, Matrix inversion, Solution of system of Linear</td></tr>
</table>

	equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization of matrices. (15) **Ordinary Differential Equations:** Existence and uniqueness of solutions of ODE (Statement Only), Equations of first order but higher degree, Clairaut's equation, Second order differential equations, Linear dependence of solutions, Wronskian
	determinant, Method of variation of parameters, Solution of simultaneous equations. (12) **Fourier series:** Basic properties, Dirichlet conditions, Sine series, Cosine series, Convergence. (4) **Laplace and Fourier Transforms:**Laplace transforms, Inverse Laplace transforms, Convolution theorem, Applications to Ordinary differential equations. Fourier transforms, Inverse Fourier transform, Fourier sine and cosine transforms and their inversion, Properties of Fourier transforms, Convolution. (10) **Probability:** Historical development of the subject and basic concepts, Axiomatic definition of probability, Examples to calculate probability, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10thed, Wiley India Ed. (2010). 2. Gilbert Strang, Linear algebra and its applications (4th Ed), Thomson (2006). 3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Ed (2017). **Reference Books:** 1. S. Kumaresan, Linear algebra - A Geometric approach, PHI (2000). 2. C. Grinstead, J. L. Snell, Introduction to Probability, American Math. Society.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC02	CO1	3	3	2	1	2	-	2	-	-	-	1	2
	CO2	3	3	2	2	2	-	2	-	-	1	-	2
	CO3	3	3	2	2	3	1	1	-	1	1	1	2
	CO4	3	2	1	3	2	1	1	1	1	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC01	**INTRODUCTION TO COMPUTING**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic knowledge of computer.		CT+MT+EA					

Course Outcomes	CO1: Recognize the changes in hardware and software technologies with respect to the evolution of computers and describe the function of system software's (operating Systems) and application software's, languages, number system, logic gates. CO2: Illustrate the flowchart and inscribe an algorithm for a given problem Inscribe C programs using operators. CO3: Develop conditional and iterative statements to write C programs. CO4: Exercise user defined functions to solve real time problems CO5: Inscribe C programs that use Pointers to access arrays, strings and functions. CO6: Exercise user defined data types including structures and unions to solve problems.
Topics Covered	Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers 2L Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. [2] Languages: Assembly language, high level language, compiler, and assembler (basic concepts) [1] Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates. [2] Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart. [1] C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements. [2] Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence, and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. [8] Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels. [5] Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register Variables, scope rules, recursion, function prototypes, C pre-processor, command line arguments. [5] Arrays and Pointers: One-dimensional, two-dimensional arrays, pointers and functions, multi-dimensional arrays. [10] Structures Union and File: Structure, union, structures and functions, arrays of structures, file read, file write.[5]
Text Books, and/or reference material	Text Books: 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie Reference Books: 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC01	CO1	3	1	2	1	-	-	-	-	-	-	-	-
	CO2	-	2	1	2	1	-	-	-	-	-	-	-
	CO3	1	2	-	-	3	-	-	-	-	-	-	-
	CO4	1	3	1	2	3	-	-	-	-	-	-	1
	CO5	2	1	-	-	3	-	-	-	-	-	-	-
	CO6	2	-	3	-	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC01	**Basic Electronics**	PCR	2	1	0	3	3
Pre-requisites			Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))				
(10+2) level mathematics and physics			CT+MT+EA				
Course Outcomes	• CO1: Knowledge of Semiconductor physics and devices. • CO2: Have an in depth understanding of basic electronic circuit, construction, operation. • CO3: Ability to make proper designs using these circuit elements for different applications. • CO4: Learn to analyze the circuits and to find out relation between input and output.						
Topics Covered	1. **Semiconductors** 1.1. Concept of band formation in solids; Fermi-Dirac distribution function, concept of Fermi level, invariance of Fermi level in a system under thermal equilibrium 1.2. Definitions of insulator, conductor and semiconductor using band diagram 1.3. Crystalline structure of semiconductor 1.3.1. Covalent bond 1.3.2. Generation of holes and electrons 1.3.3. Effect of temperature on semiconductor 1.4 Intrinsic semiconductor 1.5 Doping and Extrinsic semiconductor 1.5.1 n-Type semiconductor and band diagram 1.5.2 p-Type semiconductor and band diagram 1.5.3 Mass-action law of semiconductor 1.6. Conductivity of semiconductor (including mathematical expression) 1.7 Carrier transport phenomenon. (03 hrs.) 2. **Diodes**						

	2.1. Construction 2.2. Unbiased diode; Depletion layer and Barrier potential; junction capacitance (expression only) 2.3. Principle of operation with forward biasing and reverse biasing 2.4. Characteristics 2.5 Diode's three models/equivalent circuits.(02 hrs.) 3.**Diode Circuits** 3.1 Diode rectifier 3.1.1 Half wave rectifier 3.1.2 Full wave rectifier:centre tap and bridge rectifier 3.1.3 Capacitive filter and DC power supply (Numerical problems) 3.2 Special Diodes 3.2.1 Zenerdiode: Avalanche breakdown and Zener breakdown and characteristics. 3.2.2 Zener diode as a voltage regulator 3.2.3 Displaydevices: LED and LCD. (03 hrs.) 4.**Bipolar Junction Transistor (BJT)** 4.1 n-p-n and p-n-p transistor and their constructions 4.2 Principle of operation 4.3 Transistor configuration: common base, common emitter, and common collector 4.4 Transistor characteristics: input and output characteristics of CB and CE configurations 4.5 DC load line: quiescent (Q) point; cut-off, active, and saturation region 4.6 Amplifier: Principle of operation 4.7 Transistor as a switch. (04 hrs.) 5.**Transistor Biasing** 5.1 Need of biasing 5.2 Methods of biasing: base resistor or fixed bias, emitter feedback, voltage divider biasing 5.3 Stability of Q-point (qualitative discussions) 5.4 (Numerical problems). (02 hrs.) 6.**Single Stage Amplifier:** classification of amplifiers (voltage amplifier, current amplifier, power amplifier etc.) Class-A CE Amplifier with coupling and bypass capacitors, Qualitative discussions of magnitude characteristics of frequency response (graph only) (02 hrs.) 7.**Feedback Amplifier** 7.1 Positive and negative feedback 7.2 Deduction of gain with negative feedback, explanation of stability of gain with negative feedback, other effects of negative feedback (no deduction), numerical problems. (03 hrs.) 8.**Other Semiconductor Devices** 8.1 JFET: Construction, principle of operation, characteristics 8.2 MOSFET: Construction, principle of operation, characteristics 8.3 Power Electronic Device-SCR: Brief discussions. (02 hrs.) 9.**Operational Amplifier** 9.1 Characteristics of ideal operational amplifier

	9.2 Pin Configuration of IC 741, 9.3 Analysis of simple operational amplifier circuits: concept of virtual ground; noninverting amplifier and inverting amplifier. 9.4 Applications: voltage follower, summer, differentiator, integrator, and comparator (04 hrs) 10.**Oscillator** 10.1 Positive feedback and condition of oscillation 10.2 R-C phase-shift oscillator, Wien bridge oscillator.(02 hrs.) 11.**Boolean Algebra** 11.1 Boolean algebra, De Morgan's theorem, simplification of Boolean expressions 11.2 Number system, range extension of numbers, overflow 11.3 Different codes: gray code, ASCII code and BCD codes and them Applications. (01 hrs.) 12. **Logic Gates** 12.1 NOT, OR, AND, NOR, NAND, EX-OR, EX-NOR gates 12.2 Simplification of logic functions 12.3 Realizations of logic expressions using logic gates. (01 hrs.) 13. CRO and its applications and other test and measurement instruments. (01 hrs.)
Text Books, and/or reference material	Text Books: 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad & Nashelsky 2. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bates, 7/e. Reference Books: 1. Integrated Electronics by Millman, Halkias and Parikh, 2/e, McGrawHill. 2. ELECTRONICS Fundamentals and Applications by Chattopadhyay and Rakshit,15/e, New Age Publishers. 3. The Art of Electronics by Paul Horowitz, Winfield Hill, 2/e, Cambridge University. 4. Electronics - Circuits and Systems by Owen Bishop, 4/e, Elsevier. 5. Electronics Fundamentals: Circuits, Devices & Applications by Thomas L. Floyd & David M. Buchla, 8/e, Pearson Education.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECC01	CO1	2	3	2	2	-	1	-	-	-	-	-	1
	CO2	3	2	1	2	2	1	-	2	2	-	-	1
	CO3	3	2	2	2	3	-	-	-	2	-	-	1
	CO4	3	3	2	2	-	-	-	-	2	-	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEC01</td><td>ELECTRICAL TECHNOLOGY</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), Mid Term (MT), and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+MT+ EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Upon successful completion of this course, the student should be able to
• CO1: learn the fundamentals of Electric Circuits and Network theorems and analysis of electrical network based on these concepts.
• CO2: develop an idea on Magnetic circuits, Electromagnetism and learning the working principles of some fundamental electrical equipment’s
• CO3: learn about single phase and poly-phase AC circuits and analysis of such circuits based on these concepts.
• CO4: introduce the basic concept of single-phase transformer.
• CO5: analyze the transient phenomena in electrical circuits with DC excitation.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction: Overview of Electrical power generation systems (2)
Fundamentals of Electric Circuits: Ohm’s laws, Kirchhoff’s laws, Independent and Dependent sources, Analysis of simple circuits. (4)
Network theorems: Superposition Theorem, Thevenin’s Theorem, Norton’s Theorem, Maximum Power Transfer Theorem (4)
Magnetic circuits: Review of fundamental laws of electromagnetic induction, transformer and rotational emfs, Solution of magnetic circuits. Analysis of coupled circuits (self-inductance, mutual inductance, and dot convention)(8)
Transients with D.C. excitation for R-L and R-C circuits. (3)
Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behavior of A.C. circuits, Resonance in series and parallel R-L-C circuits. AC Network: Superposition theorem, Thevenin’s theorem, Norton’s theorem, maximum power transfer theorem, solution of networks with AC sources. (10)
Single-Phase Transformer, equivalent circuits, open circuit and short circuit tests (6)
Poly-phase system, Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current and power in a star and delta connected systems, 3-phase balanced and unbalanced circuits, Power measurement in 3-phase circuits. (5)</td></tr>
</table>

Textbooks/Reference material	Textbooks: 1. Electrical & Electronic Technology by Hughes, Pearson Education India Reference Books: 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Edu India

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	1
CO2	3	3	3	3	2	1	2	1	1	1	1	1
CO3	3	3	3	3	3	2	2	1	1	1	1	1
CO4	3	3	3	3	3	2	2	1	1	1	1	1
CO5	3	3	2	2	2	1	1	1	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
BTC01	LIFE SCIENCE	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	CO1: Basic understanding of basic cellular organization of organisms and cellular communications, structure and functions of the macromolecules and their biosynthesis and cata--bolism. CO2: To give an understanding of the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa CO3: To introduce molecular biology to understand biological processes in various applications. CO4: To provide a foundation in immunological processes and an overview of the interaction between the immune system and pathogens. CO5: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them CO6: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them						
Topics Covered	**1. Cell Biology (4)** a) Introduction to life science: prokaryotes & eukaryotes Definition; Difference b) Introduction to cells - Define cell, different types of cell c) Cellular organelles - All organelles and functions in brief d) Cellular communications						

	Introduction to basic signaling; endocrine, paracrine signaling; concepts of receptor, ligand, on-off switch by phosphorylation/dephosphorylation **2. Biochemistry (4)** a) Biological function of carbohydrate and lipid - Introduction, structure and function b) Biological function of nucleic acids and protein - structure and function c) Catabolic pathways of Macromolecules - Introduction to catabolism, hydrolysis and condensation reactions; Catabolism of glucose- Glycolysis, TCA; overall degradation of proteins and lipids d) Biosynthesis of Macromolecules Generation of ATP (ETS), Generation of Glucose (Photosynthesis) **3. Microbiology (5)** a) Types of microorganisms and their general features - Bacteria, Yeast, Fungi, Virus, Protozoa- general introduction with practical significance and diseases b) Microbial cell organization - Internal and External features of cell- bacterial cell wall, viral capsule, pilus etc, c) Microbial nutritional requirements and growth - Different Sources of energy; growth curve d) Basic microbial metabolism - Fermentation, Respiration, Sulfur, N_2 cycle **4. Immunology (5)** a) Basic concept of innate and adaptive immunity - Immunity-innate and adaptive, differences, components of the immune system b) Antigen and antibody interaction - Antigen and antibody, immunogen, factors affecting immunogenicity, basic antigen-antibody mediated assays, introduction to monoclonal antibody c) Functions of B cell - B cell, antibody production, memory generation and principle of vaccination d) Role of T cell in cell-mediated immunity - Th and Tc, functions of the T cell with respect to different pathogen and cancer cell **5. Molecular Biology (5)** a) Prokaryotic Genomes (Genome organization & structure) - Nucleoid, circular or linear b) Eukaryotic Genomes (Genome organization & structure) - Intron, exon, packaging, chromatin c) Central Dogma (Replication, Transcription and Translation) d) Applications of Molecular Biology (Diagnostics, DNA-fingerprinting, Recombinant products etc.) - Introduction to Recombinant DNA, fingerprinting, cloning **6. Bioprocess Development (5)** a) Microbial growth kinetics - Batch, fed-batch and continuous systems, Monod Equation b) Enzyme kinetics, kinetics of enzyme inhibition and deactivation Definition of enzymes, activation energy, Concepts of Km, Vmax, Ki c) Microbial sterilization techniques and kinetics Introduction to sterilization, dry and moist sterilization d) Thermodynamics of biological system - Concepts of Enthalpy, Entropy,

	favorable reactions, exergonic and endergonic reactions e) Material and energy balance for biological reactions - Stoichiometry
Text Books, and/or reference material	1. Biotechnology 01 Edition, authored by U. Satyanarayana, BOOKS & ALLIED (P) LTD. 2. Biochemistry by Lehninger. McMillan publishers 3. Microbiology by Pelczar, Chan and Krieg, Tata McGraw Hill 4. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992 5. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002. 6. Bioprocess Engineering: Basic Concepts (2nd Ed), Shuler and Kargi, PHI.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BTC01	CO1	2	1	1	-	1	-	-	-	-	-	-	-
	CO2	2	1	1	-	1	-	1	-	-	-	-	-
	CO3	2	1	1	-	1	-	-	-	-	-	-	-
	CO4	2	1	1	-	1	-	-	1	-	-	-	1
	CO5	2	1	1	-	1	1	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXC01	The Constitution of India and Civic Norms	PCR	1	0	0	1	1
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	CO1: Elementary understanding of the evolution of historical events that led to the making of the Indian constitution, the philosophical values, basic structure and fundamental concerns enshrined in the Constitution of India. CO2: Aware of the fundamental rights and duties as a citizen of the country. CO3: Enable to know the civic norms to be followed according to the Indian constitution						
Topics Covered	**1.** Historical background of the Making of Indian Constitution (1 Hour) **2.** Preamble and the Philosophical Values of the Constitution (1 Hour) **3.** Brief Overview of Salient Features of Indian Constitution (1 Hour) **4.** Parts I & II: Territoriality and Citizenship (1 Hour) **5.** Part III: Fundamental Rights (2 Hours) **6.** Part IV: Directive Principles of State Policy (1 Hour) **7.** Part IVA: Fundamental Duties (1 Hour)						

	8. Union Government: President, Prime Minister and Council of Ministers (2 Hours) **9.** Parliament: Council of States and House of the People (1 Hour) **10.** State Government: Governor, Chief Mister and Council of Ministers (1 Hour) **11.** State Legislature: Legislative Assemblies and Legislative Councils (1 Hour) **12.** Indian Judiciary: Supreme Court and High Courts (1 Hour) **13.** Centre-State Relations (1 Hour) **14.** Reservation Policy, Language Policy and Constitution Amendment (1 Hour)
Text Books, and/or reference material	Primary Readings: 1) P. M. Bakshi, *The Constitution of India*, 18th ed. (2022) 2) Durga Das Basu, *Introduction to the Constitution of India*, 25th ed. (2021) 3) J.C. Johari, *Indian Government and Politics*, Vol. II, (2012) Secondary Readings: Granville Austin, *The Indian Constitution: Cornerstone of a Nation* (1966; paperback ed. 1999); Granville Austin, *Working a Democratic Constitution: The Indian Experience* (1999; paperback ed. 2003).

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**GRAPHICAL ANALYSIS USING CAD**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Introduction to graphical solution of mechanics problems • CO2: Knowledge on graphical solution methods for solving equilibrium in coplanar force system • CO3: Introducing Maxwell diagram and solution of plane trusses by graphical method • CO4: Determination of centroid of plane figures by graphical method • CO5: Exposure to AutoCAD software for computer aided graphical solution						
Topics Covered	• Graphical analysis of problems on statics. [14] • Graphical solution of engineering problems using CAD (with the help of "AutoCAD") [14]						
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 3)… Practical Geometry and Engineering Graphics – W Abbott						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES52	CO1	2	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	2	-	-	-	-	-	-	-	-	-	-
	CO3	2	1	-	-	-	-	-	-	-	-	-	-
	CO4	2	1	-	-	-	-	-	-	-	-	-	-
	CO5	1	-	-	-	2	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**COMPUTING LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of operators, loops, branching statements, function, recursion, arrays, pointer, parameter passing techniques • CO2: To detail out the operations of strings • CO3: To understand structure, union • CO4: Application of C-programming to solve various real time problems						
Topics Covered	**List of Experiments:** 1. Assignments on expression evaluation 2. Assignments on conditional branching, iterations, pattern matching 3. Assignments on function, recursion 4. Assignments on arrays, pointers, parameter passing 5. Assignments on string using array and pointers 6. Assignments on structures, union						
Text Books, and/or reference material	**Text Books:** 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie **Reference Books:** 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS51	CO1	3	-	1	-	-	-	-	-	-	-	-	-
	CO2	-	2	1	3	-	-	-	-	-	-	-	-
	CO3	-	1	-	2	1	-	-	-	-	-	-	-
	CO4	-	-	3	2	-	-	1	-	-	-	2	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS 51	**Basic electronics Lab**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Acquire idea about basic electronic components, identification, and behavior. • CO2: To determine IV characteristics of these Circuit elements for different applications. • CO3: Learn to analyze the circuits and observe and relate input and output signals.						
Labs Conducted.	1. To know your laboratory: To identify and understand the use of different electronic and electrical instruments. 2. To identify and understand name and related terms of various electronics components used in electronic circuits.: Identify different terminals of components, fid their values and observe numbering associate with it. 3. Use of oscilloscope and function generator: Use of oscilloscope to measure voltage, frequency/time and Lissajous figures of displayed waveforms. 4. Study of half wave and Full-wave (Bridge) rectifier with and without capacitor filter circuit. 5. Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates from TTL ICs 6. Regulated power supply: study LM78XX and LM79XX voltage regulator ICs 7. Transistor as a Switch: study and perform transistor as a switch through NOT gate 8. Zenner diode as voltage regulator 9. To study clipping and Clamping circuits 10. To study different biasing cirtis. 11. Study of CE amplifier and observe its frequency response.						
Text Books, and/or reference material	Text Books: 1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul MalvinoDr., David J. Bates, et al. Reference Books: 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bates						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECS51	CO1	3	2	1	2	2	1	-	-	2	-	-	-
	CO2	3	2	2	2	3	-	-	-	2	-	-	-
	CO3	3	3	2	2	-	-	-	-	2	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES51	ELECTRICAL TECHNOLOGY LABORATORY	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	Upon successful completion of this course, the student should be able to • CO1: understand the principle of superposition. • CO2: understand the principle of maximum power transfer • CO3: understand the characteristics of CFL, incandescent Lamp, carbon lamp. • CO4: understand the calibration of energy meter. • CO5: understand open circuit and short circuit test of single-phase transformer. • CO6: analyze RLC series and parallel circuits • CO7: understand three phase connections. • C08: understand determination of B-H curve						
Topics Covered	**List of Experiments:** 1. To verify Superposition and Thevenin's Theorem. 2. To verify Norton and Maximum power transfer theorem 3. Characteristics of fluorescent and compact fluorescent lamp 4. Calibration on energy meter 5. To perform the open circuit and short circuit test on single phase transformer 6. To study the balanced three phase system for star and delta connected load 7. Characteristics of different types of Incandescent lamps 8. Study of Series and parallel R-L-C circuit 9. Determination of B-H Curve for magnetic material						
Textbooks, and/or reference material	Textbooks: 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru, J M Chuma , H U Ezea 2. Laboratory Courses in Electrical Engineering (5th Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand Publications)						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	2	2	2	3
CO2	3	3	3	3	3	1	1	1	2	2	2	3
CO3	3	3	3	3	3	1	1	1	2	2	2	3
CO4	3	3	3	3	3	1	1	1	2	2	2	3
CO5	3	3	3	3	3	1	1	1	2	2	2	3

CO6	3	3	3	3	3	1	1	1	2	2	2	3
CO7	3	3	3	3	3	1	1	1	2	2	2	3
CO8	3	3	3	3	3	1	1	1	2	2	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
XXS-52	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: (Continuous evaluation((CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Sitting Posture/Asanas- Gomukhasana, Swastikasana, Siddhasana, Ustrasana, Janusirsasana, ArdhaMatsyendrasana (Half-Spinal Twist Pose), Paschimottanasana, Shashankasana, Bhadrasana. • Mudra- Vayu, Shunya, Prithvi, Varuna, Apana, Hridaya, Bhairav mudra. • Laying Posture/Asanas- Shalabhasana (Locust Posture), Dhanurasana (Bow Posture), ArdhaHalasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, SuptaVajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- ArdhaChakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), ParshwaKonasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadisodha, Shitali, Ujjayi, Bhastrika, Bhramari. • Bandha- Uddiyana Bandha, Mula Bandha, Jalandhara Bandha, Maha Bandha. • Kriya- Kapalabhati, Trataka, Nauli. **ATHLETICS** • Long Jump- Hitch kick, Paddling, Approach run, Take off, Velocity, Techniques, Flight & Landing						

	• Discus throw, Javelin throw and Shot-put- Basic skill & Technique, Grip, Stance, Release & Follow through. • Field events marking. • General Rules of Track & Field Events. **BASKETBALL** • Shooting- Layup shot, Set shot, Hook shot, Jump shot. Free throw. • Rebounding- Defensive rebound, Offensive rebound. • Individual Defensive- Guarding the man without ball and with ball. • Pivoting. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Spike- Straight spike, Body turn spike, Tip spike, Back attack, Slide spike, Wipe out spike. • Block- Single block, Double block, Triple block, Group block. • Field Defense- Dig pass, Double pass, Roll pass. • Rules and their interpretation. **FOOTBALL** • Dribbling- Square pass, Parallel pass, Forward pass. • Heading (Standing & Running)- Fore head, Side fore head, Drop heading, Body covering during heading. • Kicking- Full volley, Half volley, Drop kick, Back volley, Side volley, Chiping (lobe). • Tackling: Covering the angle, Chessing time sliding chese, Heading time shoulder tackle etc. • Feinting- Body movement to misbalance the opponent and find space to go with ball. • Rules of Football. **CRICKET** • Batting straight drive. • Batting pull shot. • Batting hook shot. • Bowling good length, In swing. • Bowling out swing, Leg break, Goggle. • Fielding drill. • Catching (Long & Slip). • Wicket keeping technique. • Rules & Regulation. **BADMINTON** • Net play- Tumbling net shot, Net Kill, and Net Lift. • Smashing. • Defensive high clear/Lob. • Half court toss practice, Cross court toss drop practice, Full court Game practice. • Player Positioning, Placements. • Rules & Regulation. • Doubles & Mixed doubles match practice.

TABLE TENNIS

- Stroke: Backhand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin.
- Stroke: Forehand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin.
- Stroke- Backhand lob with rally, Backhand lob with sidespin, Forehand lob with rally, Forehand lob with sidespin.
- Service: Backhand/Forehand- Push service, Deep push service, Rally service.
- Service: Backhand sidespin (Left to right & Right to left).
- Service: Forehand- High toss backspin service, High toss sidespin service, High toss reverse spin service.
- Rules and their interpretations.
- Table Tennis Match (Singles & Doubles).

NCC

- FD-6 Side pace, Pace Forward and to the Rear.
- FD-7 Turning on the March and Wheeling.
- FD-8 Saluting on the March.
- FD-9 Marking time, Forward March and Halt in Quick Time.
- FD-10 Changing step.
- FD-11 Formation of Squad and Squad Drill.
- FD-12 Parade practice.

TAEKWONDO

- Poomsae (Forms)- Jang, Yi Jang.
- Self Defense Technique- Self defense from arms, Fist and Punch.
- Sparring (Kyorugi)- One step sparring, Two step sparring, Fight (Free sparring).
- Combination Technique- Combined kick and punch.
- Board Breaking (Kyokpa)- Sheet breaking.
- Interpretation Rules above Technique of Taekwondo.

NSS

- No Smoking Campaign
- Anti- Terrorism Day Celebration
- Any other observation/celebration proposed by Ministry/institute
- Public Speaking
- Discussion on Current Affairs
- Viva voce

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS52	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

THIRD SEMESTER

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MAC331</td><td>MATHEMATICS-III</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic knowledge of topics included in MAC01 & MAC02.</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Acquire the idea about mathematical formulations of phenomena in physics and engineering.
• CO2: To understand the common numerical methods to obtain the approximate solutions for the intractable mathematical problems.
• CO3: To understand the basics of complex analysis and its role in modern mathematics and applied contexts.
• CO4: To understand the optimization methods and algorithms developed for solving various types of optimization problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Partial Differential Equations (PDE): Formation of PDEs; Lagrange method for solution of first order quasilinear PDE; Charpit method for first order nonlinear PDE; Homogenous and Nonhomogeneous linear PDE with constant coefficients: Complimentary Function, Particular integral; Classification of second order linear PDE and canonical forms; Initial & Boundary Value Problems involving one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation. [14]

Numerical Methods: Significant digits, Errors; Difference operators; Newton's Forward, Backward and Lagrange’s interpolation formulae; Numerical solutions of nonlinear algebraic/transcendental equations by Bisection and Newton-Raphson methods; Trapezoidal and Simpson’s 1/3 rule for numerical integration; Euler’s method and modified Eular's methods for solving first order differential equations. [14]

Complex Analysis: Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation</td></tr>
</table>

	and Bilinear transformation; Complex integration; Cauchy's integral theorem; Cauchy's integral formula; Taylor's theorem, Laurent's theorem (Statement only); Singular points and residues; Cauchy's residue theorem. [17] **Optimization:** **Mathematical Preliminaries:** Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra. [2] **Linear Programming Problem (LPP):** Introduction; Formulation of linear programming problem (LPP); Graphical method for its solution; Standard form of LPP; Basic feasible solutions; Simplex Method for solving LPP. [9]
Text Books, and/or reference material	Suggested Text Books: 1. An Elementary Course in Partial Differential Equations-T. Amarnath 2. Numerical Methods for scientific & Engineering Computation- M.K.Jain, S.R.K. Iyengar&R.K.Jain. 3. Foundations of Complex Analysis- S. Ponnuswami 4. Operations Research Principles and Practices- Ravindran, Phillips, Solberg 5. Advanced Engineering Mathematics- E. Kreyszig Suggested Reference Books: 1. Complex Analysis-L. V. Ahfors 2. Elements of partial differential equations- I. N. Sneddon 3. Operations Research- H. A. Taha

Mapping of CO (Course Outcome) and PO (Programme Outcome):

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			2		2			2	2	3
CO2	1	2	1	1			3		2	1		3
CO3	3			2		1	2		2			3

CO4	3	3	3	2			1	2	1		2	3

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC301	Network Analysis and Synthesis	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods: Continuous (CT), Mid-Term (MT), End Assessment (EA)					
Engineering Physics (PHC01), Mathematics I and II (MAC01, MAC02)		The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.					
Course Outcomes	On successful completion of this course, students should have the skills and knowledge to: **CO1**. Applications of network theorems and Laplace transform in A.C. and D.C circuit analysis, time domain analysis of simple RLC circuits, transient analysis. **CO2**. Graph Theory. Characterization of two port networks and Z, Y, ABCD and h parameters, inter-relationships between the parameters. **CO3**. Representation of two port network in terms of T , Π and lattice networks, Bisection theorem and its applications, image impedance,characteristic impedance and propagation function **CO4**. Design of various types of attenuators and determination of insertion loss **CO5**.Design of prototype low pass, high pass, bandpass and bandstop filters, constant K-type filters, modern filter design concepts, application of filters. **CO6**.Synthesis of LC, RC and RL driving point admittance functions using Foster and Cauer first and second forms.						
Topics Covered/ Syllabus	**Unit I:Network Functions and Transient analysis (L=08 hrs.+ T=3 hrs.)** Transform Impedances,Network Theorems, Network functions of one port and two port networks, concept of poles and zeros, properties of driving point and transfer functions, time response and stability from pole zero plot, Laplace transform of various functions, Applications of Laplace transform in A.C. and D.C circuit analysis, Time domain analysis of simple RLC circuits, transient analysis. **Unit II: Two Port Networks (L=09 hrs.+T=3hrs.)** Characterization of two port networks, Z, Y, ABCD and h parameters, Reciprocity and symmetry. Inter-relationships between the parameters, Inter-connections of two port networks, T & Π Representation, Bisection theorem, Lattice network, Image impedance, Characteristic impedance and propagation function **Unit III: Network Topology (L=04 hrs +T=2 hrs.)** Network graph, Tree, Incidence matrix - Fundamental cutsets and fundamental loops – Tie set and cut set schedules – V shift and I shift – Formulation of equilibrium equation on loop basis and node basis, Formulation of equilibrium equation in matrix form – Duality, Construction of dual of a network. **Unit IV: Attenuators (L=05 hrs.+ T=2 hrs.)** Image and scattering parameters, insertion loss. Various types of attenuators (Lattice, T, Π etc. networks). **Unit V: Filters (L=07 hrs.+ T=3 hrs.)** Filters: conditions of passband and stopband, design of prototype low pass, high pass, bandpass and bandstop sections, constant K-type filters, modern filter design						

	concepts, application of filters. **Unit VI: Network Synthesis(L=07 hrs.+ T=3 hrs.)** Hurwitz polynomials and properties – Positive real functions and its properties; definition and properties; properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point admittance functions using Foster and Cauerfirst and second forms.
Text Books, and/or Reference material	**Text Books**: 1. E. Van Valkenburg, "Network Analysis", Prentice Hall of India 2. C. L Wadhwa, "Network Analysis and Synthesis" New Age International Publishers, 2007, 3. D. Roy Choudhury, "Networks and Systems" Wiley Eastern Ltd. 4. John D. Ryder, "Networks, Lines & Fields", 2nd edition, Pearson
	Reference Books/materials: 1. B. C. Kuo, "Network Analysis and Synthesis", John Wiley 2. E. Van Valkenburg, "An Introduction to Modern Network Synthesis", Wiley Eastern Ltd. 3. A. Chakrabarti, "Circuit Theory" DhanpatRai& Co.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	2	1	-	-	-	-	-	-	3	2	3	2
CO#2	3	3	2	3	2	-	-	-	-	-	-	3	3	2	2
CO#3	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
CO#4	3	2	2	3	2	-	-	-	-	-	-	2	3	3	2
CO#5	3	3	3	3	2	1	-	-	-	-	-	2	3	2	2
CO #6	3	2	3	3	2	-	-	-	-	-	-	2	2	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC302	Electronic Devices and Circuits-I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods: Continuous (CT), Mid-Term (MT), End Assessment (EA)					
Engineering Physics (PHC01), Electrical Technology (EEC01), Basic electronics (ECC01)		The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.					
Course Outcomes	CO # 1. Understanding the fundamental knowledge of analog devices and circuits CO # 2. To become familiar with the design of much more complex electronic circuits with the help of those fundamentals. CO # 3. Enriching historical developments with facts that led to this theory. Emphasis is given on IC technology but it originates from vacuum tube era. CO # 4. To be aquatinted with the present day design tools using which one can synthesize						

	and analyze the complex design problems. CO # 5. Understanding the devices and circuits as a basic building block of electrical communication and other areas and enhancing problem solving skills.
Topics Covered	**1. P-N Junction Diode:(4L+1T)** Qualitative Theory of P-N Junction, P-N Junction as a Diode, Diode Equation, Volt-Ampere Characteristics, Temperature dependence of V-I characteristic, Ideal versus Practical – Resistance levels(Static and Dynamic), Transition and Diffusion Capacitances, small Signal Model and Its Application, Diode Equivalent Circuits, Load Line Analysis, Breakdown Mechanisms in Semiconductor Diodes, Zener Diode Characteristics. **2. Special Purpose Electronic Devices: (4L+1T)** Principle of Operation and Characteristics of Tunnel Diode (with the help of Energy Band Diagram), Varactor Diode, SCR and Semiconductor Photo Diode. **3. Rectifiers and Filters :(4L+1T)** The P-N junction as a Rectifier, Half wave Rectifier, Full wave Rectifier, Bridge Rectifier, Harmonic components in a Rectifier Circuit, Inductor Filters, Capacitor Filters, L- Section Filters, π- Section Filters, Comparison of Filters, Voltage Regulation using Zener Diode. **4. Bipolar Junction Transistor and UJT: (6L+2T)** The Junction Transistor, Transistor Current Components, Transistor as an Amplifier, Transistor Construction, BJT Operation, BJT Symbol, Common Base, Common Emitter and Common Collector Configurations, Limits of Operation, BJT Specifications, BJT Hybrid Model, Determination of h-parameters from Transistor Characteristics, Comparison of CB, CE, and CC Amplifier Configurations, UJT and Characteristics; BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response **5. Transistor Biasing and Stabilization:(7L+2T)** Operating Point, The DC and AC Load lines, Need for Biasing, Fixed Bias, Collector Feedback Bias, Emitter Feedback Bias, Collector - Emitter Feedback Bias, Voltage Divider Bias, Bias Stability, Stabilization Factors, Stabilization against variations in V_{BE} and β, Bias Compensation using Diodes and Transistors, Thermal Runaway, Thermal Stability, Analysis of a Transistor Amplifier Circuit using h – Parameters: **AC Models:** Base-Biased Amplifier, Emitter-Biased Amplifier, Small-Signal operation, AC Beta, AC Resistance of the Emitter Diode, Two Transistor models, Analyzing an Amplifier **6. Field Effect Transistor**:**(7L+2T)** The Junction Field Effect Transistor (Construction, principle of operation, symbol) – Pinch-off Voltage - Volt-Ampere characteristics, The JFET Small Signal Model, MOSFET (Construction, principle of operation, symbol), MOSFET Characteristics in Enhancement and Depletion modes. FET Amplifiers: FET Common Source Amplifier, Common Drain Amplifier, Generalized FET Amplifier, Biasing FET, FET as Voltage Variable Resistor, MOSFET small signal model– Analysis of CS, CG and CD amplifiers – Gain and frequency response- High frequency analysis. Comparison of BJT and FET amplifiers. **7. Multistage Amplifiers: (6L+2T)** Introduction; Amplifier frequency response, Gain Bandwidth product, Need for multi-stage amplification; R-C coupled amplifiers, Cascode configuration **8. Operational Amplifiers: (6L+2T)** Basics of operational amplifiers, open loop and closed loop response, Application of op−amps (Non−linear applications): viz, inverting and non inverting amplifiers, voltage follower, adder, substractor, differentiator and integrator, Comparators, clippers and clampers, Schmitt triggers, precision rectifiers, peak detectors, Log and Antilog amplifiers, gyrator, Current to voltage and voltage to current converters, Instrumentation and isolation amplifiers, transducer Bridge amplifiers. General op−amp

	circuit design and detailed circuit description.
Text Books, and/or reference material	**Text Books:** 1. J. Millman, C.C.Halkias, "Electronic Devices and Circuits" 2. Thomas L. Floyd, "Electronic Devices", 8th Edition, Pearson Education Inc., 2007 **Reference Books:** 1. Mohammad Rashid, "Electronic Devices and Circuits" Cengage Learing, 2013 2. Schilling and Belove, "Electronic Circuits: Discrete and Integrated",McGraw-Hill Education , 3rd Ed. 3. Robert Boylestad and Louis Nashelsky, " Electronic Device and Circuit Theory", PHI; 9th Edition, 2007 4. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", 6th Edition, Oxford University Press, 2006 5. David A. Bell, "Electronic Devices and Circuits" 5 Ed, Oxford

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#2	2	2	3	2	3	1	-	-	-	-	-	2	2	3	2
CO#3	2	2	3	3	3	2	1	-	-	-	-	2	3	3	3
CO#4	2	3	2	3	3	-	-	-	-	-	-	-	3	3	2
CO#5	2	3	3	3	3	-	-	-	-	-	-	2	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC303	Signals and Systems	PCR	3	0	0	3	3
Prerequisites		Course Assessment methods (Continuous (CT), Mid-Term (MT), End Assessment (EA))					
Mathematics I and II (MAC01, MAC02)		The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.					
Course Outcomes		• CO1: To realize the difference between (i) continuous and discrete signals, (ii) analog and digital signals. • CO2: Understand mathematical techniques to solve problems involving convolution, filtering, modulation and sampling. • CO3: Ability to apply mathematical transforms for signals and systems analysis. • CO4: Analysis of stable LTI systems.					

	• CO5: Practical realization of various forms of anti-aliasing filters.		
Topics Covered mapped to Course Outcomes	Topic Details	(No. of classes)	Course Outcomes (COs)
	Classification of signals, basic operation on signals such as time scaling and time shifting, elementary signals, impulse function, introduction to system properties such as stability, memory, causality, invertibility, time invariance and linearity.	2	CO#1, CO#4
	Analyzing linear time invariant (LTI) systems through convolution sum and convolution integral, correlation of signals, relation between convolution and correlation, interconnection of LTI systems, relations between LTI system properties and impulse response, step response.	5 3	CO#2, CO#4 CO#2, CO#4
	Analyzing LTI systems through discrete time difference equation and continuous time differential equation models, natural response, forced response, transient response and stability.	8 4	CO#3
	Concepts on Fourier series, Discrete time Fourier series, Fourier transform and Discrete time Fourier transform. Thorough analysis of the properties of Fourier representations in connection with real time systems.	3	CO#2,CO#3, CO#5
	Relationship between the various Fourier representations, applications of Fourier representation to mixed signal classes, analyzing sampling of signals through Fourier transforms.	5	CO#2, CO#3, CO#5 (**Self-Learning Module**)
	Discrete Fourier transform, properties of DFT, circular convolution, computations for evaluating the DFT, decimation in time and decimation in frequency FFT algorithms.	4	CO#2, CO#3, CO#4
	Other essential transforms: Hilbert transforms, properties of Hilbert transforms, representation of complex envelope and bandpass signals.	4	CO#3, CO#4
	Haar transform, wavelet functions, continuous and discrete wavelet transforms, non-adaptive and adaptive transform coding, wavelet coding.	4	CO#3, CO#4
	Complex frequency concept, Bilateral and Unilateral Laplace transforms, properties, inversion, solving differential equations with initial conditions, transfer function, causality and stability analysis, determining the frequency response from poles and zeros.		CO#2, CO#4 (**Self-Learning Module**)
	Z transform, properties, inversion, transfer function, causality and stability, determining the frequency response from poles and zeros, computational structures for implementing discrete time LTI systems.		
	Application to linear feedback systems, sensitivity and		

	distortion analysis, stability problem, Routh-Hurwitz criterion, Nyquist stability criterion, sampled data feedback systems.		
Text Books, and / or reference material	**Text Books**: 1. Signals and Systems -- Simon Haykin. 2. Principles of Linear Signals and Systems -- B.P.Lathi 3. Signals and Systems --Tarun Kumar Rawat **Reference Books**: 1. Signals and Systems: Schaum's Outline. 2. Discrete-Time Signal Processing -- Oppenheim, Schafer and Buck. 3. Digital Signal Processing-- Proakis and Manolakis. 4. a Wavelet tour of signal processing, The Sparse Way -- StéphaneMallat.		

COURSE ARTICULATION MATRIX

Mapping the Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#2	1	2	3	3	3	-	-	-	-	-	-	3	3	2	2
CO#3	2	1	3	3	3	-	-	-	-	-	-	3	3	2	2
CO#4	2	3	3	3	2	-	-	-	-	-	-	3	3	2	2
CO#5	1	1	3	3	3	-	1	-	-	-	-	3	3	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC331	Physics of Semiconductor Devices	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Engineering Physics (PHC01)		CT+MT+EA					
Course Outcomes	At the end of the course, a student will be able to: **CO1**.Describe the different electronic properties of semiconductor materials. **CO2**. Understand the working principal of electronic devices (PN Diode, Photodetector, Solarcell, Light-EmittingDiodes, Laser Diodes, JFET, MOSFET, Tunnel Diode, Gunn Diode, IMPATT Diode, TRAPATT Diode and semiconductor memory). **CO3**. Apply the knowledge of memory expansion to design required expanded memory for specific application.						
Topics Covered	**Fundamentals of Semiconductor & SemiconductorDevicesFabrication:** Introduction to crystal growth, Intrinsic and extrinsic semiconductors, Fermi level, Conductivity, Mobility and its temperature dependence, Energy bands of semiconductors, Direct and indirect semiconductor, Variation of energy band with alloy composition, III-V and II-VI alloy semiconductor, Homo and hetero-structure						

	semiconductor, Effective masses of carriers in semiconductor, Fermi-Dirac distribution function, Density of states, Carrier concentrations at equilibrium, Calculation of number density of carriers and their temperature dependence, Effects of temperature on carrier concentrations, High field effects, Hall effect, Lithography, Optical lithography and Electron beam lithography. **[14L]** **Junction-Diode&OptoelectronicDevices:** P-N junction, Contact potential, Banddiagram, Degenerate semiconductors, Photodetector,Solarcell, Light-EmittingDiodes, Internal and external quantum efficiency etc.,SemiconductorLasers, Population inversion at a junction, Emission spectra for P-N junction Lasers.**[3L]** **Negative Conductance Microwave Devices:** Materials for negative conductance devices, The Gunn effect and related devices, The transferred electron mechanism, Transit time devices, The IMPATT Diode, the TRAPATT Diode, TunnelDiode. **[10L]** **JFETandMOSFET:** JunctionFieldEffectTransistors(JFET),Operation,I-VCharacteristics etc.,MOSstructure, Different MOS structures, Operation of MOS at high and low frequency, Accumulation, Inversion, strong inversion regions,Metal-OxideSemiconductor FieldEffectTransistors(MOSFET),MOSFETasaCapacitor,MOSFETasa resistorandrelatedcircuits. **[9L]** **Semiconductor Memory Device:** Semiconductormemoryorganization,RandomAccessMemory(RAM)(staticanddynamic),CMOS memorycircuits,ChargeCoupledDevices (CCD).**[6L]**
Text Books, and/or reference material	**Text Books:** 1. PhysicsofSemiconductorDevices,SMSZE. 2. SolidStateElectronicDevices,BenGStreetman & Banerjee 3. Microwave Solid-State Devices, S Y Liao **Reference Books:** 1. SemiconductorPhysicsand Devices,Donald A.Neamen. 2. Microwave Engineering, David M.Pozar. 3. IntegratedElectronics,Millman-Halkias.

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome):

PO/PSO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	1	2	1	-	1	1	1	-	-	-	2	-	-	1
CO#2	3	2	1	1	1	1	1	1	1	1	-	2	1	1	1
CO#3	3	3	2	1	1	1	1	1	1	1	1	1	2	2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 27				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS351	Network Analysis and Synthesis Lab	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods: Continuous (CT) and End Assessment (EA)					
Electrical Technology (EEC01)		CT+EA					

Course Outcomes	CO#1 Understand the basics of DC (direct current) circuits. CO#2 Use Mutisim Simulator for circuit simulation CO#3 Able to apply network circuit theorems to analyze electrical circuits CO#4 Use an oscilloscope to measure frequency, period, voltage (magnitude, peak-to-peak, maximum, minimum, and etc), DC offset, etc, of the waveform CO#5 Understand the difference between over-damped, critically damped and under-damped circuits from the observation of step response.
Laboratory experiments covered	1. Experiment with DC Measurements 2. Experiment with AC Measurements 3. Experiment with Network Analysis Methods 4. Experiment with First Order Circuits 5. Experiment with Second Order Circuits 6. Experiment with Sinusoidal Steady State 7. Experiment with Series & Parallel Resonance 8. Experiment with Transfer Functions 9. Experiment with Frequency Response Approach: Laboratory experiments of this course are devoted to elementary design of linear circuits. In particular, time is devoted to (a) the transient voltage response of RC, RL and RLC circuits, (b) the sinusoidal steady-state response of RC, RL and RLC circuits, and (c) the frequency response of series RLC resonance networks, and the impacts on the frequency response by varying capacitance and resistance.
Text Books, and/or reference material	Reference Books/ Materials: 1. B. C. Kuo, "Network Analysis and Synthesis", John Wiley 2. E. Van Valkenburg, "An Introduction to Modern Network Synthesis", Wiley Eastern Ltd. 3. Teri L. Piatt (Author), Kyle E. Laferty, "Circuit Analysis Laboratory Workbook (Synthesis Lectures on Electrical Engineering) Lab Manual, Workbook Edition" Morgan & Claypool. 4. Laboratory Instruction Manual.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	2	1	1	-	-	-	1	1	-	1	2	1	1
CO#2	3	2	2	1	1	1	-	1	1	1	-	1	2	1	1
CO#3	3	3	3	1	1	-	-	-	1	1	-	1	3	3	2
CO#4	1	2	1	1	1	-	-	-	1	1	-	1	3	3	2
CO#5	2	3	1	2	1	-	-	-	1	1	-	1	2	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Course Name	Program Core (PCR)/Elective (PEL)	Total Number of contact hours = 27				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	

ECS352	Electronics Devices and Circuits Lab	PCR	3	0	0	3	1.5

Pre-requisites	Course Assessment Methods: Continuous (CT) and end Assessment (EA)
Basic Electronics (ECC01)	CT+EA
Course Outcomes	CO#1: Acquire knowledge of identifying analog ICs CO#2: Gain knowledge of designing linear and non-linear analog circuits using transistor CO#3: Develop skills to design amplifier, oscillators and PLL CO#4: Acquire skills to implement analog circuits using breadboard CO#5: Develop acquaintance to use electronic test and measurement instruments.
List of Experiments	1. Design and set up the BJT common emitter amplifier using voltage divider bias and determine the gain bandwidth product from its frequency response. 2. Design and set up the BJT common collector amplifier using voltage divider bias and determine the gain bandwidth product from its frequency response. 3. Design, setup and plot the frequency response of Common SourceJFET amplifierandobtainthe bandwidth. 4. Design and test a 1 kHz relaxation oscillator using UJT 5. Linear Application of Op-Amp (Inverting amplifier, Non-inverting amplifier). 6. Integrator and Differentiator using IC741 Op-Amp 7. Adder and Subtractor using Op-Amp. 8. Mono-stable Multivibrator using IC 555. 9. Astable Multivibrator using IC 555. 10. Schmitt Trigger Circuit using IC741. 11. IC565 PLL Applications. 12. Voltage Regulator using IC723. 13. RC phase shift & Wien Bridge oscillator using IC741.
Text Books, and/or reference material	**Reference Materials:** 1. Brian Dean, Introduction to Analog& Digital Circuits Lab Manual, kendall hunt Pub Co, 2018 2. NAVAS, K. A., *Electronics Lab Manual (VOLUME 1 and 2), PHI, Sixth Edition* 3. Departmental Lab Manual

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	2	-	-	-	-	-	1	1	-	1	2	2	1
CO#2	2	3	3	2	1	-	-	-	1	1	-	1	2	3	1
CO#3	2	3	3	1	1	-	-	-	1	1	-	1	3	2	2
CO#4	1	2	3	2	1	-	-	-	2	1	-	1	3	2	2
CO#5	2	1	2	2	1	1	-	-	3	1	1	1	2	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective	Total Number of contact hours = 24				Credit
			Lecture	Tutorial	Practical	Total	

		(PEL)	(L)	(T)	(P)	Hours	
PHS381	Semiconductor Devices Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and End Assessment (EA))					
Physics Laboratory (PHS51)		CE+EA					
Course Outcomes	At the end of the course, a student will be able to: **CO1**. Calculate different characteristic parameter of semiconductor materials. **CO2**. Measure and understand different characteristic of semiconductor devices. **CO3**. Draw the current-voltage characteristics of solar cell for calculation of conversion efficiency.						
Topics Covered	**List of Experiments:** 1. To determine the energy bandgap of a semiconductor. 2. Measurement of resistivity of semiconductors by four-probe method at different temperatures. 3. Determination of Hall coefficient of a given semiconductor and its temperature dependence. 4. To determine the value of e/m of an electron by using a cathode ray tube and a pair of bar magnet. 5. Determination of Stefan's constant. 6. Study of p-n junction diode characteristics. 7. Study of Zener diode characteristics and voltage regulator. 8. Determination of photo conversion efficiency of a Solar cell.						
Text Books, and/or reference material	**Text Books:** 1. An advanced course in practical physics,Chattapadhyay and Rakshit. 2. Advanced Practical Physics, B. Ghosh and K. G. Mazumdar						

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome):

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	2	1	-	-	-	-	1	1	1	-	2	1	-	1
CO#2	3	2	1	-	-	-	-	1	1	1	-	2	1	-	1
CO#3	3	2	1	-	1	1	1	1	1	1	-	2	2	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

FOURTH SEMESTER

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC401	Analog Communication	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods (Continuous (CT), Mid-Term (MT), End Assessment (EA))
Network Analysis & Synthesis (ECC 301) Signal and Systems (ECC 303)	The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.

Course Outcomes	At the end of the course, the students will be able to **CO1**: Define and state the elements of communication systems and issues related to transmission of signals through communication channels, radio wave propagation. **CO2**: Explain time and frequency domain equations for all forms of amplitude modulation schemes and corresponding circuits, signals and spectra. **CO3**: Use various analog pulse communication systems and solve problems related to FDM and super heterodyne receiver. **CO4**: Formulate time and frequency domain equations for angle modulation systems and justify related circuits, signals and spectra. **CO5**: Differentiate between various types of noise, and compare noise resistance, noise figure and noise temperature and discuss probability theory, random variables and random processes with related significance in communication systems. **CO6**: Assemble complete analog communication system and formulate the expression of figure of merit for different schemes of modulation.
Topics Covered	1. Introduction: Advantages of Electrical communication; block diagram of an electrical communication system, the fundamental limitation of communication systems. Communication channels and propagation characteristics [**7(L+T)**] 2. Amplitude Modulation and Demodulation: DSB, SSB, VSB. Spectra, Circuits and Systems. [**12(L+T)]** 3. Frequency Modulation and Demodulation: Spectra, Circuits and Systems. [**12(L+T)**] 4. Pulse Modulation: Sampling theorem and its proof. PAM, PWM, PPM [**5(L+T)]** 5. Probability, Random Variable & Random Processes: Mean, Moments, ACF, PSD and WSS, Ergodic and other random processes. [**10(L+T)]** 6. Noise. Noise Figure, Noise Temperature, Performance of Analog communication systems in the presence of Noise. [**10(L+T)**]
Text Books, and/or reference material	**Text Books**: 1. Principle of Communication Systems- H.Taub&D.L.Schilling (TMH). 2. Modern Digital and Analog Communication Systems- B.P.Lathi (Oxford). **Reference Books**: 1. K. Sam Shanmugam, Digital and Analog Communication Systems, Wiley. 2. B. Sklar, Digital Communications, PHI. 3. S. Haykin& M. Moher, Introduction to Analog & Digital Communication, Wiley.

COURSE ARTICULATION MATRIX

Mapping Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO #2**	**PSO #3**
CO#1	2	1	2	1	1	2	1	2	-	-	-	2	2	2	3
CO#2	2	2	3	3	2	-	-	-	-	-	-	2	3	2	2
CO#3	1	1	3	1	2	1	-	-	-	-	-	2	2	2	2

CO#4	3	3	2	2	2	-	-	-	-	-	-	2	3	3	3
CO#5	3	3	3	2	3	-	-	-	-	-	-	3	3	3	2
CO#6	2	3	2	3	2	1	2	-	-	-	-	2	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 56</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECC402</td><td>Digital Circuits and Systems</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT), Mid-Term (MT), End Assessment (EA))</td></tr>
<tr><td colspan="3">Electronic Devices and Circuits I (ECC302)
Basic Electronics (ECC01)</td><td colspan="5">The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Understand rules of Boolean Algebra and use it for logic synthesis.
● CO2: Design logic circuits using switches, transistors and integrated circuit building blocks.
● CO3: Understand binary number system and design corresponding arithmetic circuits.
● CO4: Explain and implement A/D and D/A converters.
● CO5: Learn sequential circuit building blocks and implement Finite State Machines.
● CO6: Understand principles of Error Detection and Correction codes.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module 1: (L- 1, T-1)
Introduction: Definition of Analog & Digital information. Characteristics of Digital Circuits. Advantages of Digital systems.
Module 2: (L-1 , T- 1)
Boolean Algebra: Introduction – rules of Boolean Algebra, axioms, D'Morgan's theorems
Module 3: (L-2 , T- 1)
Logic Gates: Basic Gates, Universal Gates, Realization of logic gates using switches, Transistors (MOS and BJT) as switch.
Module 4: (L-4 , T-2)
Logic Synthesis: Two level synthesis, SOP/POS forms, canonical forms; Minimization of logical function by - i) Algebraic method, ii)Karnaugh Map method and iii) QuineMccluskey Method.
Module 5: (L-4 , T-2)
Combinational Circuits: Multiplexer, Demultiplexer, Decoder, Encoder, decoder driver, designing using these combinational circuits and their applications.
Module 6: (L-3 , T- 2)
Digital Arithmetic: Number systems, Binary arithmetic, Representing negative numbers – sign-magnitude, 1's complement and 2's complement representations; Arithmatic circuits - Half Adder and Full adder Circuits, multi-bit ripple-carry adder and subtractor circuits. Realization of these circuits using Multiplexers.
Module 7: (L- 6, T-4)
Sequential Circuits: Definition, Elements of sequential circuits - Latches and Registers,</td></tr>
</table>

	Different kinds of flip-flops – R-S, J-K, Master-slave arrangement, D, and T type registers; Finite state machines - Moore and Mealy machines; Typical sequential circuits -counters, shift registers and sequence generator; synchronous and asynchronous circuits. **Module 8: (L-4 , T- 2)** Multivibrator: Definition of different types of Multivibrators, their realization by logic gates, op-amp and transistors. 555 Timer IC. **Module 9: (L-3 , T- 2)** A/D & D/A Converter: Different types of D/A & A/D Converters. **Module 10: (L- 3, T-2)** Codes and Code converters: Gray code, Excess-3 code, BCD Code, BCD to 7-segment decoder: Error Detection and Correction codes - error detection by parity checking, Principle of error correction, Hamming code. **Module 11: (L- 4, T-2)** Different logic families such as RTL, DCTL, DTL, HTL, TTL, ECL, MOS & CMOS logic family their importance and applications.
Text Books, and/or reference material	**Text Books**: 1. M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003. 2. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2004. **ReferenceBooks**: 1. John.M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2002. 2. William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982. 3. Thomas L. Floyd, Digital Fundamentals, 8th Edition, Pearson Education Inc, New Delhi, 2005. 4. Donald D. Givone, Digital Principles and Design, TMH, 2016. 5. John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	2	2	1	-	-	-	-	-	-	3	3	2	2
CO#2	2	3	3	3	2	-	-	-	-	-	-	2	3	2	1
CO#3	2	3	3	3	3	-	-	-	-	-	-	3	2	3	3
CO#4	2	3	3	3	3	-	-	-	-	-	-	2	3	2	2
CO#5	3	3	3	2	3	-	-	-	-	-	-	3	2	3	2
CO#6	1	2	3	1	1	-	-	-	-	-	-	2	1	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC403	Electromagnetic Theory and Transmission Lines	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT), End Assessment (EA))					

Mathematics II (MAC02), Engineering Physics (PHC01), Electrical Technology (EEC01)	The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.
Course Outcomes	CO # 1. Understanding electromagnetic theory as a basic building block of electrical communication and enhancing problem solving skills. CO # 2. Enriching historical developments with facts that led to this theory. Emphasis on the fact that we are actually discussing Maxwell's electromagnetic theory. CO # 3. Enhancing theoretical knowledge from a clear viewpoint of phenomenon associated when charges are *at rest*, charges *moving with constant velocity* and during *acceleration/ deceleration* which is results in time harmonic fields. CO # 4. Understanding underlying aspect of radio wave propagation in various media, retarded potentials and concept of radiated waves. CO # 5. Assimilating the transmission line theory as a merger of filed theory and network theory. Imbibing the fundamental aspects of Telegrapher's equation and its essence in the analysis of transmission line parameters.
Topics Covered	Historical foundations that led to Maxwell's electromagnetic theory **[L-2]** Electrostatics: Coulomb's law and Field Intensity, Gauss's law- Maxwell's Equation, Application of Gauss's Law, Electric Potential. Electrostatic Boundary-Value Problem: Poisson's and Laplace's Equations, Uniqueness Theorem, Resistance and Capacitance, Method of Images. Electric Fields In Material Space: Properties of Materials, Convection and Conduction Currents, Polarization in Dielectrics, Dielectric Constant and Strength, Continuity Equation and Relaxation Time.**[L-10; T-02]** Magnetostatic Fields: Biot-Savart's Law, Ampere's Circuit Law-Maxwell's Equation, Application of Ampere's law, Magnetic Flux Density-Maxwell's Equation, Maxwell's Equations for Static Fields, Magnetic Scalar and Vector Potentials, Derivation of Biot-Savart's Law and Ampere's Law. Magnetic Forces, Materials, and Devices:Forces due to Magnetic Fields, magnetic Torque and Moment, A Magnetic Dipole, Magnetization in Materials, Classification of Materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits, Force on Magnetic Materials, Analogy between Electrostatics and Magnetostatics **[L-8; T-02]** Time Varying Fields, Waves, and Applications: Maxwell's Equations:Faraday's law, Transformer and Motional EMFs, Displacement Current, Maxwell's Equations in Final Forms, Time-Varying Potentials, Time-harmonic Fields**.[L-8; T-02]** Electromagnetic Wave Propagation: Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Plane Waves in Free Space, Plane Waves in Good Conductors, Skin depth, Wave Polarization, Power and the Poynting Vector, Reflection of a Plane Wave at Oblique Incidence.**[L-8; T-02]** Transmission Lines: Introduction to different types of planar and non-planar guided media, Transmission line parameters, Telegrapher's equation, Input impedance, SWR, Power flow in transmission lines, Introduction to parallel plate and hollow metallic waveguides. **[L-10; T-02]**
Text Books, and/or reference material	**Text Book:** [1] Matthew O H Sadiku, *Principles of Electromagnetics*, 4/e, Oxford University Press. **Reference books:** [1] E. C. Jordan and K. G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2/e, PHI (Addison Wesley). [2] J. D. Ryder, "Networks, Lines and Fields", Pearson [3] David. M. Pozar, *Microwave Engineering*, 2/e, 1998 (John Wiley & Sons). [4] S. Ramo, J. R. Whinnery, and T. Van Duzer, *Fields and Waves in Communication Electronics*, 3/e, John Wiley and Sons, 1994. [5] David K. Cheng, *Field and Wave Electromagnetics*, 2/e, 1989. [6] R. E. Collin, "Foundations for Microwave Engineering", John Wiley

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	1	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2
CO#4	1	2	1	1	1	3	2	1	2	1	1	1	3	3	2
CO#5	2	3	1	2	1	1	1	1	2	1	1	1	2	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 44				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC431	Control Systems	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods: Continuous (CT), Mid-Term (MT), End Assessment (EA)					
Engineering Physics (PHC01), Signals and Systems (ECC303)		The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.					
Course Outcomes	At the end of the course students will be able to: **CO1**: Understand the basic objectives of control system design. **CO2**: Derive input-output relationship of systems based on their mathematical modeling governed by basic laws of physics. **CO3**: Justify stability of systems based on their transfer functions, time domain and frequency domain specifications. **CO4**: Develop concepts on root pattern with variable gains and comment on the stability. **CO5**: Determine the stability of closed-loop system based on open loop frequency response. **CO6**: Design controllers so as to meet design specifications both in time as well as frequency domain. **CO7**: Realize the controller both in software simulation through MATLAB coding as well as in real-time environment.						
Topics Covered	**Introduction to control systems**:[4L] Historical development, Open and Closed loop systems, Applications, Effects of feedback, Types of feedback control systems, Servomechanism. **Mathematical Models of Physical Systems**:[4L] Modeling of electrical networks, Modeling of mechanical system elements, Transfer functions, Block diagram Algebra, Signal flow graph and Mason's Gain formula. **Introduction to State Variable Approach**:[4L] Concepts of state, state variables and state model state models for linear Continuous-time systems, state transition matrix. **Representation of Control Components**: [2L] Electrical components, Mechanical components, Electromechanical Components. **Time domain analysis and design specification of linear systems**:[8L] Standard signals, Transient response and S-plane root locations of Second and higher order systems, Design specifications, steady state errors and error constants, effects of						

	adding poles and zeros to transfer functions, P, PI, PD and PID controllers. **Concepts of Stability and Algebra Criterion**:[4L] Concept of stability, characteristic equation necessary conditions for stability, Routh-Hurwitz stability criteria. **Root Locus Technique**:[4L] The root locus concept, construction of Root Loci, Important properties parameters design byRoot locus method, Root-locus Plots with MATLAB. **Frequency Response Analysis and Stability Studies in Frequency Domain**:[10L] frequency domain specifications, correlation between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability, Conditionally stable system, M and N loci on complex and gain phase plan MATLAB tools and case studies. **Design and Compensation Technique**:[4L] Preliminary considerations of classical Design, Realization of Basic compensators, Frequency domain and S-plane design techniques,Example of control systems. Design with MATLAB.
Text Books, and/or reference material	**Text Books**: 1. J. Nagrath and M Gopal, Control system Engineering, New Age International Publishers 2. K. Ogata, Modern Control Engineering, Prentice Hall. 3. B. C. Kuo, Automatic control system, John Wiley & Sons **Reference Books**: 1. Norman S. Nise, Control system Engineering, John Wiley & Sons 2. B. Shahian and M. Hassul, Control System Design using MATLAB, Prentice Hall.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	3	2	1	1	-	-	-	-	2	3	2	2
CO#2	3	3	2	3	2	-	-	-	-	-	-	1	3	2	2
CO#3	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#4	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#5	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#6	3	2	3	3	3	1	1	1	-	-	-	2	3	3	2
CO#7	3	2	3	3	3	1	-	1	-	-	-	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 24				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS451	Analog Communication Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods Continuous (CT) and end assessment (EA)					
Network Analysis & Synthesis (ECC301)		CT+EA					

Course Outcomes	CO1: Understand the fundamentals to explain the functionality of modulation and demodulation. CO2: Analyze the concepts, write and simulate the concepts of AM and AM Demodulation process in Communication. CO3: Know FM and FM-Demodulation process in communication. CO4: Discriminate the AM and FM functionalities. Interpret with various angle modulation and demodulation systems. CO5: Create the simulation environments in PAM, PWM, PPM and verification of circuit and waveform in software platform.
Labs Conducted.	12. To generate amplitude modulated wave and determine the percentage modulation. 13. To demodulate the modulated wave using envelope detector. 14. To observe the output waveform of each block of super heterodyne receiver. 15. To measure modulation index in FM and show the demodulated waveform. 16. To perform pulse amplitude modulation and demodulation 17. To perform pulse position modulation and demodulation 18. To perform pulse width modulation and demodulation 19. To observe DSB, DSB-SC, SSB waveforms in time domain and frequency domain in MATLAB platform. 20. To observe DSB, DSB-SC, SSB waveform in time domain and frequency domain in MATLAB platform. 21. To design transmitter and receiver circuit for amplitude modulation using discrete components. 22. To design transmitter and receiver circuit for frequency modulation using discrete components.
Text Books, and/or reference material	**Text Books**: 3. Morden Analog & Digital Communication System- B.P. Lathi 4. Digital and Analog Communication Systems– K. Sam Shanmugam. 5. Principle of Communication Systems- Taub& Schilling. **Reference Materials**: 6. Lab instruction manual 7. Instruction manuals provided by manufacturer

COURSE ARTICULATION MATRIX

Mapping ofCourse Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO #2**	**PSO #3**
CO#1	3	2	1	1	-	-	-	-	-	1	1	1	2	2	2
CO#2	3	3	2	2	1	-	-	-	-	1	-	-	2	3	2
CO#3	3	3	2	2	1	-	-	-	-	1	-	-	2	2	2
CO#4	3	2	-	1	-	-	-	-	-	-	-	-	2	1	1
CO#5	2	2	2	3	3	-	-	-	-	1	1	1	3	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 30</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS452</td><td>Digital Circuits and Systems Laboratory</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods:
Continuous (CT), End Assessment (EA)</td></tr>
<tr><td colspan="3">Basic Electronics (ECC01)</td><td colspan="5">The assessment methods comprise of quizzes and multiple choice type questions based on laboratory work and developing experimental set ups.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After conducting the laboratory experiments student will be able to:
CO1: Understand digital circuits as basic building blocks of electrical communication, control system with enhanced problem solving skills.
CO2: Enrich knowledge of historical developments with facts that led to this theory leading to Integrated Circuits domain.
CO3: Design and develop complex digital circuits for electronics appliances.
CO4: Develop subsystems for the design of digital computers.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Experiment :1
1.1 Design of half adder and half subtractor circuit using nand gates only.
1.2 Design of 5-bit even / odd parity checker circuit using xor gate.
Experiment: 2
2.1Realization of multiplexer as universal logic gate.
2.2 Design full adder and full subtractor circuit using4:1 multiplexer
Experiment: 3
3.1 Realising a bcd to decimal decoder circuit using decoder driver and seven segment led display.
3.2 Verifying the function table of 8 to 3 line priority encoder.
Experiment: 4
4.1 Design of four bit one’s complement binary adder / subtractor circuit.
4.2 Design of four bit two’s complement binary adder / subtractor circuit.
4.3Design of four and five bit digital magnitude comparator.
Experiment: 5
5.1Verification of excitation table of J-K flipflop.
5.2 Verification of excitation table of D flipflop.
5.3Design of T type flip flop from D type flipflop.
Experiment: 6
6.1 Design of asychronous up counter using J-K flipflop.
6.2Design of sychronous up counter using D flipflop.
Experiment: 7
7.1 Study of asynchronous decade counter IC, 7490 in different modes.
7.2 Study of asynchronous binary counter or mod 16 counter IC 7493 in different modes.
Experiment: 8
8.1Study of synchronous decade counter IC 74160 in different modes.
8.2Study of synchronous up / down counter IC 74192.
Experiment: 9
9.1Study of 64-bit read / write memory.
9.2Study of 4-bit universal shift register.
Experiment: 10
10.1Study of 4-bit arithmatic logic unit.</td></tr>
</table>

Text Books, and/or reference material	**Text Book**: 1. M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003. **Reference Books**: 1. John.M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2002. 2. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2004. 3. William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982. 4. Thomas L. Floyd, Digital Fundamentals, 8th Edition, Pearson Education Inc, New Delhi, 2005 5. Donald D. Givone, Digital Principles and Design, TMH, 2016. 6. John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	1	1	-	-	-	-	-	1	1	1	2	2	2
CO#2	3	3	2	2	1	-	-	-	-	1	-	-	2	3	2
CO#3	3	3	2	2	1	-	-	-	-	1	-	-	2	2	2
CO#4	3	2	-	1	-	-	-	-	-	-	-	-	2	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 30				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES481	Control Systems Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods Continuous evaluation (CE) and End Assessment (EA)					
ECC303(Signals and Systems)		CE+EA					
Course Outcomes	• CO1: To understand the dynamic behaviour of real-time systems. • CO2: To simulate physical systems in real-time environment. • CO3: To design control system to improve the performance characteristics of real-time systems. • CO4: To determine the parameters and transfer function of physical systems from real-time experimentation. • CO5: To get acquainted with MATLAB programming, MATLAB-SIMULINK in order to simulate, analyze and design of control system design for different plants under consideration.						
Topics Covered	1. DC Servo Speed Control System 2. DC Servo Position Control System 3. Temperature Control System 4. Linear System Simulator 5. Lead and Lag Network 6. P, PI and PID controller 7. Study of Different real-time systems through Simulation in MATLAB 8. PID Design Method for DC motor Speed Control using MATLAB						

	9. Root Locus Design Method for DC motor Speed Control using MATLAB 10. DC motor Speed Control Based on Frequency Response using MATLAB
Text Books, and/or reference material	**Text Books:** 1. J. Nagrath and M Gopal, *Control system Engineering*, New Age International Publishers. 2. K. Ogata, *Modern Control Engineering*, Prentice Hall **Reference Books:** 1. B. Shahian, M. Hassul, *Control System Design using MATLAB*, Prentice Hall. 2. Laboratory instruction manuals.

COURSE ARTICULATION MATRIX

Mapping Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome(PSO)														
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	3	2	1	1	-	-	-	-	2	3	2	2
CO#2	3	3	2	3	2	-	-	-	-	-	-	1	3	2	2
CO#3	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#4	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#5	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

FIFTH SEMESTER

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 56</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECC501</td><td>Digital Communication</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods:
(Continuous (CT), Mid-Term (MT), End Assessment (EA))</td></tr>
<tr><td colspan="2">Analog Communication (ECC401)</td><td colspan="6">The assessment methods comprise of quizzes, multiple choice type questions, and subjective questions all either designed in google form or assessed through pen and paper.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1:Acquire idea about analog to digital conversion.
• CO2:Understand simultaneous transmission of digital signals.
• CO3:Learn communication techniques for wired channels.
• CO4:Analyze and mitigate interference in wired channels.
• CO5:Learn communication techniques for wireless channels.
• CO6:Differentiate between different coding and modulation strategies.
• CO7: Understand the basic concepts of Information theory, Source and Channel Coding, Channel Capacity and relation among them
• CO8 : Learn basics of random process, modeling and analysis of systems with random signal</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module 1: Introduction to digital communication [3 hrs.]

Module 2:Review of random process [5 hrs.]
Basic definition, Stationarity, Ergodicity, autocorrelation, cross correlation, power spectral density, Response of Linear systems to Random inputs, Gaussian process, Narrow band noise, Rayleigh pdf
Module 3:Waveform coding [12 hrs.]
PCM – generation, regenerative transmission, detection; Linear quantization, quantization noise, non-uniform quantization, companding; Channel noise and error probability; TDM, PCM-TDM hierarchy; Delta modulation, adaptive delta modulation.
Module 4:Baseband transmission [12 hrs.]
Line coding – types, criterions for choosing a line code, power spectra; ISI, Nyquist criterion for zero ISI, eye pattern; Mitigation of ISI – raised cosine filtering, equalization. Matched filter.
Module 5: Passband transmission [12 hrs.]
Relation between amplitude, time period, and energy, characterization of noise, signal space representation; Binary modulations – ASK, PSK, FSK. QPSK, MSK; Generation, detection (coherent/ non-coherent), power spectra, and error probability of digital CW modulations.
Module 6: Information theory and coding [12 hrs.]
Measure of information, Entropy, Joint and Conditional entropy, Self and Mutual Information, Channel capacity and Shannon’s law; Coding for compression –Source coding theorem, variable length coding, Huffman coding; Coding for error correction – Noisy coding theorem, parity checking, Hamming code, Generator and Parity Check Matrices, Linear block codes.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. Introduction to Analog & Digital Communications - S. Haykin, M. Moher.
2. Digital Communication - J. G. Proakis, M. Salehi.
Reference Books:</td></tr>
</table>

	1. Digital Communications - S. Haykin. 2. Modern Digital and Analog Communication Systems - B. P. Lathi, Z. Ding. 3. A First course in Digital Communications - H. H. Nguyen, E. Shwedyk. 4. Principles of Communications - R. E. Ziemer, W. H. Tranter. 5. Principles of Communication Systems - H. Taub and D. L. Schilling. 6. Digital and Analog Communication Systems - K. S. Shanmugan. 7. Digital and Analog Communication Systems - L. W. Couch. 8. Digital Communications - B. Sklar. 9. Theory and Design of Digital Communication Systems - T. T. Ha.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	3	2	2	3	1	1	1	1	1	1	3	2	2
CO#2	2	2	2	3	2	3	2	1	1	1	2	1	2	3	3
CO#3	3	2	2	2	3	2	2	1	1	1	1	1	2	3	2
CO#4	2	3	3	3	3	2	1	1	1	2	1	2	3	2	2
CO#5	3	2	2	2	3	2	2	1	1	1	1	1	2	3	2
CO#6	2	3	2	3	2	2	1	1	1	2	2	1	3	2	3
CO#7	3	3	3	3	2	2	1	1	1	1	1	1	3	2	3
CO#8	3	3	3	3	2	2	1	1	1	1	1	1	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC502	Microwave Engineering	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT), End Assessment (EA))					
Electromagnetic Theory and Transmission lines (ECC403)		CT+MT+EA					
Course Outcomes		**CO1:** Understand behaviour of transmission lines and waveguides, gain complete knowledge about Microwave components. **CO2:** Analyze and explain the characteristics of microwave passive components. **CO3:** Analyze and explain the characteristics of microwave active components and circuits. **CO4:** Acquire knowledge about the measurements at microwave frequencies.					

Topics Covered	**Module – I:** (L – 2; T -1) **Wave Propagation in Unbounded and Bounded Media**: Classification of Waves - TEM Waves, TE Waves and TM Waves, Parallel Plate Waveguide – TEM modes, TE modes, and TM modes; Solution techniques for modes and boundary conditions, Wave Velocities - Phase Velocity, Group Velocity, Energy-Flow Velocity. [T1] **Module – II:** (L – 6; T -3) **Waveguides:** General properties of rectangular and circular waveguides, Solution of wave equation – TE Modes, TM Modes, power transmission, power losses, excitation of modes, characteristics of standard rectangular waveguides. Solution of wave equation – TE Modes, TM Modes and TEM modes in circular waveguide, power transmission, power losses, excitation of modes, characteristics of standard circular waveguide [T1, T2] **Module – III:** (L – 2) **Dielectric waveguide and surface wave:** Surface Waves on a Grounded Dielectric Slab – TM Modes, TE – Modes. [T1, T2] **Module – IV:** (L – 2; T -1) **Impedance Matching:** Concept of impedance in guided waves, Smith-chart and its use, Impedance matching techniques - quarter wave transformer, single stub, double stub. [T2 and T3] **Module – V:** (L – 3; T -1) **Microwave Resonators:** Rectangular Waveguide Cavity resonators - Resonant Frequency, Q – factor; Circular Waveguide Cavity resonators - Resonant Frequency, Q – factor; Dielectric Resonators - Resonant Frequency; Excitation of Resonators. [T1, T2] **Module – VI:** (L – 3; T -1) **Microwave Network Theory:** Equivalent Voltages and Currents, The Concept of Impedance, Impedance and Admittance Matrices, Scattering parameters, Signal Flow Graphs, ABCD Matrix [T1] **Module – VII:** (L – 3; T -1) **Microwave Passive Components:** E-plane Tee, H-plane Tee, Magic Tee, Hybrid ring, circulator, isolators, Attenuator, Phase-shifter, directional coupler, slotted section, windows (Capacitive and Inductive), Irises. [T1, T2] **Module –VIII:** (L – 4; T -2) **Microwave Solid-state Devices:** Solid state microwave sources based on IMPATT diode, TRAPATT Diode, Gunn diode, Tunnel diode, Detectors and mixers: PIN diode, Schottky Diode, Varactor, diode, Step recovery diode. [T2] **Module – IX:** (L – 3; T -1) **Microwave Vaccum Tube Devices:** Microwave Amplifiers: Klystron amplifiers, TWT – space TWT and Helix TWT, Magnetron. [T2] **Module – X:** (L – 2; T -1) **Microwave Measurement and Communication:** Measurement of microwave power, impedance, standing wave, frequency and phase-shift. Microwave antenna, Line of sight propagation, microwave links, satellite communication. [T3]
Text Books, and/or reference material	**Text Books**: T1. D M Pozar, “Microwave Engineering”, Fifth Edition, Wiley India, New Delhi, India, 2005. T2. Liao, Samuel Y., “Microwave devices and circuits 3/E”, Pearson Education India, 1989. T3. Collin, Robert E., “Foundations for microwave engineering 2/E”, John Wiley & Sons, 2007. **Reference Books**: R1. Radmanesh, Matthew M., “Radio frequency and microwave electronics illustrated”, New Jersey: Prentice Hall, 2001.

	R2. CA Balanis, Advanced Electromagnetic Engineering, John Wiley, New York, 2003. R3. Cheng, David Keun, "Field and wave electromagnetics", Pearson Education India, 1989.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	3	2	1	1	1	1	1	1	-	-	-	1	3	1	2
CO#2	3	2	2	2	2	-	-	-	-	-	-	1	3	2	2
CO#3	3	2	2	2	2	1	-	1	-	-	-	1	2	2	3
CO#4	3	2	1	1	1	1	1	1	-	-	-	1	3	2	3

Correlation levels 1, 2 or 3 as defined above:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) and "-" if there is no correlation.

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC503	Microprocessors and Microcontrollers	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods: (Continuous (CT), Mid-semester assessment (MA) and End Assessment (EA)):					
Digital Circuits and Systems (ECC402)		CT+MT+EA					
Course Outcomes	At the end of the course, a student will be able to: • **CO1 Describe** the fundamental operations and internal architectures of microprocessors and Microcontroller's as well as **identify** the peripherals to be used for the given microprocessor and Microcontroller based problems. • **CO2 Understand** the performance of Microprocessor (8085 & 8086) and Microcontroller based systems and **select** appropriate platform to meet specified requirements. • **CO3 Apply** the knowledge of Microprocessors, Microcontrollers and peripheral devicesand demonstrate the programming proficiency using the various instruction codes of the target microprocessor and microcontroller. • **CO4 Analyze** different problems on microprocessors and microcontrollers and write appropriate assembly language programs. • **CO5 Evaluate** the machine codes to providesolutions to the real-world problems. • **CO6 Design** necessary I/O and Memory interfacing circuitry to communicate Microprocessor and Microcontroller with external devices.						
Topics Covered	**Module – I:** (L – 6; T -2) **Introduction to Microprocessor:** Basic computer architecture, stored program computer concept; Evolution of Microprocessors, 8085 Architecture, drawbacks and Instruction sets and programming with 8085.[CO#1, 2, 3, 4, 6]; [T1] **Module – II:** (L –7; T - 3) **Microprocessor 8086/8088:** 8086: Architecture-Functional diagram, Register organization, signal description, Memory Segmentation, physical memory organization, general bus						

	operation, I/O addressing capability, special purpose activities, Minimum mode, maximum mode of 8086 system and timings, the processor 8088, Programming Model, machine language instruction formats, addressing modes, instruction set, assembler directives and operators. Macros and Simple Programs involving Logical, Branch and Call Instructions, Sorting, String Manipulations. [CO#1, 2, 3, 4, 6]; [T1, T2, R1, R2] **Module – III:** (L – 5; T - 2) **Programming with 8086:** Machine level programs, programming with an assembler, Assembly language programs, and introduction to stack, stack structure of 8086/8088, interrupts and interrupt service routines, interrupt cycle of 8086, non-mask able interrupt and mask able interrupts, interrupt programming, The coprocessor 8087. [CO# 3, 4, 5];[T2, R1, R2] **Module – IV:** (L – 6; T - 2) **I/O And Memory Interface:** LCD, Keyboard, External Memory RAM, ROM Interface, ADC, DAC Interface to 8051. Serial Communication and Bus Interface: Serial Communication Standards, Serial Data Transfer Scheme, On board Communication Interfaces-I2C Bus, SPI Bus, UART; External Communication Interfaces-RS232,USB. [CO#1, 3, 6]; [T2, R2] **Module – V:** (L – 6; T - 2) Programmable Peripheral Interfacing: Description and programming of Intel 8255, 8257, 8155, 8253, 8251 and 8259A, 8279A etc.[CO#1, 3, 6];[T2, R1] **Module – VI:** (L – 1) **Development of Processors:** 80186, 80386, RISC.[CO# 1, 5]; [T2, R2] **Module – VII**; (L – 5; T - 2) **Microcontrollers:** Introduction, Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes and Instruction set of 8051. 8051 Real Time Control: Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Programming 8051 Timers and Counters, assembly language programming tools.[CO#1, 3, 4, 6]; [T3, R3] **Module – VIII:** (L – 2) **PIC Microcontrollers:** Introduction, Architecture, ALU, Program memory, register, Instruction Interrupts, Peripherals. [CO# 1, 3, 6]; [T4, R4] **Module –IX:** (L – 4, T -1) **Arduino Microcontroller Board and ARM:** Introduction, Introducing the Arduino Board Installing and familiarizing the Arduino IDE, Connection diagram examples and program code. ARM Special Features and applications, Architecture, Registers, processor modes, instructions, stack organization, ARM I/O System, memory interface, pipeline organization, simple example of ARM based embedded system.[3, 4, 6]; [T5, R5-R7]
Text Books, and/or reference material	**Text Books** 1. Microprocessor, Architecture, Programming and Applications with Microprocessor 8085;Author: Ramesh S. Gaonkar (5th Edition); Publisher – Prentice Hall **(Modules I)** 2. Advanced Microprocessors and Peripherals, Authors: A. K. Ray, K. M. Bhurchandi; Publisher - Tata McGraw Hill. **(Modules I – VI)** 3. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, Pearson Education. **(Modules VII)** 4. PIC Microcontrollers; Author - M. Bates; Publisher - Newnes. **(Module VIII)** 5. The AVR Microcontroller and Embedded Systems Using Assembly and C: Using Arduino Uno and Atmel Studio; *Author* – SepehrNaimi and SarmadNaimi, Muhammad Ali Mazidi; *Publisher* – Majidi and Naini**(Modules IX)** **References:** 1. Microprocessors and Interfacing: Programming and Hardware; Authors: Douglas V. HallPublisher - Tata McGraw Hill 2. The Intel Microprocessors – Architecture, Programming and Interfacing; Authors: Barry B. Brey; Publisher: Pearson Education

	3. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed. 4. The 8051 Microcontroller: A Systems Approach; Authors: M.A. Mazidi, R.D. McKinlay, J.G. Mazidi; Publisher- Pearson. 5. Embedded microcontroller and processor design; Authors: G. Osborn; Publisher: Pearson 6. *Arduino Cookbook;* Authors: Michael Margolis, Publisher: O'Reilly Media, Inc, 7. W.A. Smith, "ARM Microcontroller Interfacing: Hardware and Software, Eketor, 2010.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome):

PO/PSO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	1	3	3	1	1	1	1	-	-	-	2	2	2	1
CO#2	3	2	2	1	1	1	-	1	-	-	-	1	2	1	1
CO#3	3	3	3	1	1	1	1	1	-	-	-	1	3	3	2
CO#4	1	2	3	2	1	1	-	1	-	-	-	1	3	3	2
CO#5	2	3	1	2	1	2	2	1	-	-	-	1	2	3	2
CO#6	3	2	3	2	1	-	-	-	-	-	-	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC504	Electronic Devices and Circuits-II	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods: ((Continuous (CT), Mid-Term (MT), End Assessment (EA))					
Electronic Devices and Circuits I (ECC302), Basic Electronics (ECC01), Network Analysis and Synthesis (ECC301)		Assignments, Mid Semester and End Semester Examination					
Course Outcomes	At the end of this course students will be able to: CO # 1. Understand the fundamental principles of amplifiers and oscillators. CO # 2. Able to design Power Amplifiers CO # 3. Become familiar with the design of wave shaping circuits. CO # 4. Able to design regulated power supply circuits CO # 5. To be able to make use of the recently developed electronic devices in solving the present day complex electronic systems.						
Topics Covered	**1. Output Stages and Power Amplifiers (6L+2T)** Classification of Output Stages; Power Amplifier, Class A, Class B, Class AB and Class C amplifiers, Biasing the Class AB Stage; Push-Pull Amplifiers – Transformer Coupled and Complementary symmetry configurations; Tuned Amplifiers, Class – D amplifiers, Power Transistors–Power B.J.T'S Power MOSFETs, Power amplifier designing, Thermal analysis and						

	Heat sinks; **2. Feedback Amplifiers And Oscillators (9L+2T)** Introduction to Feedback, Basic Feedback Concepts, Ideal Close−Loop Gain, Advantages of negative feedback, Gain Sensitivity, Bandwidth Extension, Noise Sensitivity, Reduction of Non−Linear Distortion; Feedback Topologies, Series−Shunt, Shunt−Series, Series−Series, Shunt−Shunt Configurations, The Stability Problem, Bode Plots, One−Pole, Two−Pole and Three−Pole Amplifiers, Nyquist Stability Criterion, Phase and Gain Margins, Frequency Compensation Basic Theory, Closed Loop Frequency Response, Miller Compensation; Positive feedback, Condition for oscillations, phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators. Phase shift oscillators, Wien bridge oscillators, Tuned circuit oscillators, **3. Differential AMPLIFIER (6L+2T)** Differential amplifier – Common mode and Difference mode analysis – FET input stages – Amplifier biasing: current source and Current mirror – Gain and frequency response – Neutralization methods. **4. Operational Amplifiers (7L+2T)** Basics of operational amplifiers, open loop and closed loop response, Application of op−amps, viz, inverting and non inverting amplifiers, voltage follower, adder, substractor, differentiator and integrator, Comparators, clippers andclampers, Schmitt triggers, precision rectifiers, peak detectors, Log and Antilog amplifiers, gyrator, Current to voltage and voltage to current converters, Instrumentation and isolation amplifiers, transducer Bridge amplifiers. General op−amp circuit design and detailed circuit description. **5. Signal Generator and Waveform-Shaping Circuits (6L+1T)** Op Amp-RC Oscillator Circuits; LC and Crystal Oscillators; Generation of Square and Triangular Waveforms Using AstableMultivibrators; Integrated Circuit Timers; **6. Power Supplies, Breakdown Diodes, and Voltage Regulators (6L+2T)** Unregulated Power Supply; Basics of voltage regulators, Performance specifications; linear regulators, Current Limiting; Integrated Circuit Voltage Regulators, IC 78XX, 79XX, LM317, IC 723; Voltage references - Bandgap Voltage Reference; switching regulators and monolithic switching regulators, DC to DC convertors. **7. Special-purpose Devices (5L)** Schottky barrier diodes, , MIS diode, heterojunctions devices, Tunnel Diode (with the help of Energy Band Diagram), Varactor Diode, UJT, SCR.
Text Books, and/or reference material	**Text Books:** J. Millman, C.C.Halkias, "Electronic Devices and Circuits" Thomas L. Floyd, "Electronic Devices", 8th Edition, Pearson Education Inc., 2007 **Reference Books:** Mohammad Rashid, "Electronic Devices and Circuits" Cengage Learing, 2013 Schilling and Belove, "Electronic Circuits: Discrete and Integrated",McGraw-Hill , 3rd Ed. Robert Boylestad and Louis Nashelsky, " Electronic Device and Circuit Theory", PHI; 9th Edition, 2007 A.S. Sedra and K.C. Smith, "Microelectronic Circuits", 6th Edition, Oxford Univ. Press, 2006 David A. Bell, "Electronic Devices and Circuits" 5 Ed, Oxford.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#2	2	2	3	2	3	-	1	-	-	-	-	2	2	3	2
CO#3	2	2	3	2	1	-	-	-	-	-	-	2	3	2	2

Department of Electronics and Communication Engineering															
CO#4	2	3	2	3	3	2	1	1	-	-	-	2	3	3	2
CO#5	2	3	3	3	2	1	1	1	-	-	2	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering						
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 24			Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS551	Digital Communication Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))					
Analog Communication Laboratory (ECS451)		CE+EA					
Course Outcomes	• **CO1:Acquire** idea about analog to digital conversion. • **CO2:Understand** simultaneous transmission of digital signals. • **CO3:Learn** communication techniques for wired channels. • **CO4:Analyze** and mitigate interference in wired channels. • **CO5:Learn** communication techniques for wireless channels. • **CO6:Differentiate** between different coding and modulation strategies.						
Topics Covered	List of experiments 1. Pulse code modulation (PCM) - Generation and detection 2. Delta modulation (DM) - Generation and detection 3. Adaptive delta modulation (ADM) - Generation and detection 4. Sampling and signal reconstruction 5. Time division multiplexing (TDM) 6. Line coding 7. Amplitude shift keying (ASK) - Generation and detection 8. Phase shift keying (PSK) - Generation and detection 9. Frequency shift keying (FSK) - Generation and detection						
Text Books, and/or reference material	**Text Books/Reference Manual**: 1. Introduction to Analog & Digital Communications - S. Haykin, M. Moher. 2. Digital Communication - J. G. Proakis, M.Salehi. 3. Lab. instruction manual.						

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	3	2	-	-	-	-	2	1	1	1	3	2	2
CO#2	2	2	2	3	-	-	-	-	2	1	-	1	2	3	3
CO#3	3	2	2	2	3	-	-	-	1	1	-	1	2	3	2
CO#4	3	3	2	2	-	-	-	-	1	2	-	2	3	2	2
CO#5	3	3	2	2	-	-	-	-	1	1	-	1	2	3	2
CO#6	3	3	1	2	-	-	-	-	1	2	-	1	3	2	3

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 18				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS552	Microwave Engineering Lab	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
Electromagnetic Theory and Transmission Lines (ECC403)		Day to day evaluation during the laboratory session and End Semester Examination					

Course Outcomes	After successful completion of this course, the students will be able to CO#1: **Realize** the characteristics of Microwave sources and passive components. CO#2: **Use** microwave test bench to measure Frequency, wavelength and VSWR. CO#3:**Analyze** the characteristics of microwave sources. CO#4:**Arrange** complete microwave test bench to observe the characteristics of different microwave components.
List of Experiments	1. Study of the characteristics of Gunn Diode and Gunn Oscillator 2. Study of the characteristics of magic-Tee and directional coupler 3. Measurement of source frequency, guided wavelength and VSWR using microwave test bench 4. Measurement of input impedance with unknown load. 5. Use of Microwave Power meter 6. Study of reflex-klystron characteristics A. Measurement of output power using power meter B. Plot of beam voltage vsrepeller voltage. C. Plot of frequency vs. Repeller voltage. D. Plot of frequency vs. Output power.
Text Books, and/or reference material	**Text Books**: **[**T1**]** Sisodia and Raghuvangshi, Microwave Laboratory Manual, New Age International. [T2]Lab. Instruction manual. **Reference Books**: [R1] Balanis, Antenna Theory and Design, Wiley Publications [R2] John D. Krauss, Antennas for all Applications, TMH. [R3]Edward C.Jordan and Keith G.Balmain" Electromagnetic Waves and Radiating Systems" Prentice Hall of India.

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	1	2	1	-	-	-	-	1	1	-	1	2	2	1
CO#2	3	2	2	-	-	-	-	-	2	1	-	1	2	1	1
CO#3	3	1	2	2	1	-	-	-	-	1	-	1	3	3	2
CO#4	3	2	1	1	-	-	-	-	1	1	-	2	3	2	1

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 30</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS553</td><td>Microprocessors and Microcontrollers Laboratory</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Digital Circuits and Systems (ECC402)</td><td colspan="5">Day to day evaluation during the laboratory session and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of thisseasonal course, a student will be able to:
• Recognize the different parts of Microprocessors, Microcontrollers and peripheral devices.
• Interpret methodologies to be adopted for the specified problems on Microprocessors and Microcontrollers.
• Apply appropriate instruction codes to develop the program for Arithmetic, logical, data transfer and copying operations as well as data communication to external devices.
• Analyze requirements of experimental setup of using Microprocessor and Microcontroller.
• Construct the necessary interfacing circuitry to communicate Microprocessor and Microcontroller with the external devices.</td></tr>
<tr><td>List of Experiments</td><td colspan="7">Part A: Programming using Microprocessor 8085 Kit
1. Perform the following arithmetic operations
a) Addition and subtraction of two 8 bit nos.
b) Addition and subtraction of two 16 bit nos.
c) Multiplication and division of two 8 bit nos.
2. Determination of factorial of a given number.
3. Display Fibonacci series.
4. Determination of the smallest and largest element of an array.
5. Sorting the data array as follows
a) Ascending order.
b)Descending order.
6. Generation of the following waveforms
a) Triangular.
b) Square.
7. Interfacing with stepper Motor.
Part B: Programing using Microprocessor 8086 Kit and simulator
1. Perform the following arithmetic operations of two 16 bit nos.
a) Addition.
b) Subtraction.
c) Multiplication.
d) Division.
2. Determination of factorial of a given number.
3. Move contents of an array from one memory location to another location.
4. Perform the following conversions of the number system
a) Convert a given decimal no. to hexadecimal.
b) Convert a hexadecimal no.</td></tr>
</table>

	5. Separation of odd and even nos. 6. Determination of the sum of n consecutive nos. of an array. 7. Sorting the elements of an array as follows a) Ascending order. b) Descending order. 8. Reverse a given string and verify whether it is a palindrome or not. 9. Interfacing with stepper Motor. 10. Interfacing with 7 segment display. 11. Interfacing with keyboard controller. **Part C: Programing using Microcontroller 8051 Kit and simulator** 1. Perform the following arithmetic operations of two 16 bit nos. a) Addition. b) Subtraction. c) Multiplication. d) Division. 2. Exchange the contents of two memory locations. 3. Determination of the sum of first n natural nos. using 8051 Microcontroller. 4. Check whether given number is palindrome or not. 5. Determination of the largest and smallest no. of a data array. 6. Sorting the data array as follows a) Ascending order. b) Descending order. 7. Perform the following conversions of the number system a) BCD to ASCII. b) ASCII to Decimal. c) Decimal to ASCII. 8. Generation of 1 second delay continuously using on-chip timer. 9. Interfacing with stepper motor. 10. Generation of square waveform. 11. Interfacing with LCD. **Part D: Programming on ARDUINO Microcontroller Board** 1. Blink the on board LED. 2. Generation of square waveform. 3. Interfacing with LCD.
Text Books, and/or reference material	**Text Books** 1. Lab. instruction manual and operation manuals supplied by the manufacturers. 2. Microprocessor Architecture, Programming and Applications with the 8085; Authors: R. Gaonkar; Publisher -, Prentice Hall. 3. Advanced Microprocessors and Peripherals, Authors: A. K. Ray, K. M. Bhurchandi; Publisher Microprocessors and Interfacing: Programming and Hardware; Authors: Douglas V. HallPublisher - Tata McGraw Hill. 4. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, Pearson Education. 5. The 8051 Microcontroller: A Systems Approach; Authors: M.A. Mazidi, R.D. McKinlay, J.G. Mazidi; Publisher- Pearson.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
~~PO/PSO~~	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PSO**	**PSO**	**PSO**

CO	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#1	#2	#3
CO#1	2	-	-	-	1	-	-	-	-	-	-	1	2	1	1
CO#2	3	-	3	-	2	1	-	-	1	1	-	1	2	1	1
CO#3	3	1	2	1	2	1	-	-	1	1	-	1	1	3	1
CO#4	3	1	2	1	2	1	-	-	1	1	-	1	1	3	1
CO#5	3	3	3	1	1	-	-	-	-	1	-	1	2	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 43</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>HSC631</td><td>Economics and Management Accounting</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT), Mid-Term (MT) and End Assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1:To make budding engineers aware of various aspects of micro economic theories which will help engineers to take decision in the organization
• CO2:To impart knowledge on various tools and techniques applied in economics by the executives of an organization
• CO3:To make potential engineers aware of macro economics variables affecting business
• CO4:To impart knowledge on basics of accounting procedure and functional knowledge required in the area of accounting decision making</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Group A: Microeconomics
Unit 1: Economics: Basic Concepts (2)
(a) Introduction to study of Economics and Microeconomics for Engineers
(b) Markets and Prices: definition, extent
(c) Demand and Supply – market mechanism – market equilibrium – elasticity of demand and supply – market equilibrium – short run versus long run
(d) Understanding the effects of changing market conditions
(e) Effects of government intervention in market – price control(2L)
Unit 2: Theory of Consumer Behaviour
(a) Utility – ordinal utility – cardinal utility – constructing a utility function – some examples of utility function – Marginal Utility (MU)
(b) Consumer preferences – assumptions about preferences – indifference curves – perfect substitutes, perfect compliments – the marginal rate of substitution (MRS)
(c) The budget constraint – properties of budget set – change of budget line – taxes, subsidies and rationing
(d) Optimal choice – consumer demand – price changes and income changes – normal versus inferior goods – Engel curves – income effect and substitution effect and Giffen good
(e) Price Consumption Curve and the demand curve – Slutsky decomposition – ordinary versus compensated demand curve
(f) Elasticity of demand – direct effect, cross effect, substitutes and compliments
(g) Consumer surplus – compensating variation and equivalent variation(3L)</td></tr>
</table>

	Unit 3: *Theory of Production, Cost and Firms* (a) Technology of production – production function (b) Properties of production function with one variable input – average product and marginal product (c) Law of Diminishing Marginal Returns (d) Iso-quants, input flexibility, diminishing rate of factor substitution (e) Iso-cost curves (f) Optimizing behaviour of the firm (g) Long-run and the short-run – returns to scale (h) Cobb-Douglas Production, CES Production Function (i) Measuring cost: Economic cost versus accounting cost, opportunity cost, sunk cost, fixed cost, variable cost (j) Long-run versus short-run costs (k) Economies of scale – short run and long run(3L) Unit 4: *Analyses of Market Structures: Perfect Competition* (a) Perfect Competition – assumptions – price taking behaviour (Demand curve of an individual firm) (b) Supply schedule – very short period, short period and long period (c) Equilibrium of an individual firm (d) Long run industry supply curves – constant, increasing and decreasing cost industry (e) Efficiency of competitive market – consumer and producer surplus effects of tax and subsidy, price control(3L) Unit 5: *Monopoly Market* (a) Average Revenue and Marginal Revenue (b) Monopolist's output decision (c) The effect of tax on monopoly output and price (d) Multiplant Monopolist (e) Price discrimination – First and Second Degree - Two part tariff - Third Degree (f) Monopoly Power – Mark-up Pricing (g) Social cost of monopoly (h) Dead-weight loss (i) Natural Monopoly(2L) Unit 6: *General Equilibrium and Welfare Economics* (a) Interdependence in the economy (b) 2 persons 2 goods Pure Exchange Model – Edgeworth Box Diagram (c) Contract Curve (d) Existence of Equilibrium – offer curve (e) Walras' Law (f) General Equilibrium with production – 2 good 2 factor case (g) Contract curve (h) Production Possibility Frontier (i) Pareto optimality (j) Externalities in consumption and production – market failure Group B: Macroeconomics Unit 1: *Introduction to Macroeconomic Theory (2L)* (a) Introduction to study of Economics and Macroeconomics for Engineers (b) Economy as a circular flow between firm sector and household sector – Firm, Household and Government (c) Basic Macroeconomic Variables - Configurations of Aggregate Output, Employment, Interest and Price Level (d) Fundamental Macroeconomic Problems – unemployment, inflation

	(e) Fluctuation of output – rate of growth – high unemployment, hyper -inflation, depression and stagflation Unit 2: *National Income Accounting (3L)* (a) Gross National Product (GNP) (b) Gross Domestic Product (GDP) (c) Net National Product (NNP) (d) Personal Income (PI) (e) Relation between GNP, GDP, NNP and PI (f) Nominal and Real GNP (g) GNP Deflator (h) Methods of Measurement of GNP – Measuring Gross Value of GNP – Factor Share Method, Expenditure Method, Value Addition Method (i) Foreign or External Sector Unit 3: *Determination of Equilibrium Level of Income(3L)* (a) Aggregate Demand – Components – Consumption, Investment, Government Expenditure and Net Exports (b) Consumption Function – Consumption and Savings (c) Investment Function (c) Aggregate Demand (d) Equilibrium Output – Keynesian Cross Diagram (e) Multiplier (f) Stability of Equilibrium Output (g) Paradox of Thrift (h) Government Sector – Government Budget – the Balanced Budget Multiplier (i) Taxes as a function of income (j) Multiplier and changes in tax rate (k) The Goods Market – Consumption Demand – Investment Demand (l) Planned Investment and Interest Rate (m) Goods' Market Equilibrium – IS Curve Derivation Unit 4: *Money, Interest and Income(4L)* (g) Money: Definition and Components of Money Demand and Money Supply. (h) Money Market Equilibrium – LM Curve (i) Equilibrium in goods and money market (j) Dynamic Equilibrium Condition: Changes in Equilibrium levels of income and interest rate (l) Monetary Policy – Transmission Mechanism (m)Liquidity Trap – Interest inelasticity (n) Fiscal Policy and Crowding Out (o) Effectiveness of Fiscal and Monetary Policy in terms of IS-LM Model (p) Derivation of Aggregate Demand Function (C-M Curve) Unit 5: *Inflation and Unemployment (2L)* (a) Inflation – Measures, types and effects (b) Classical Theory of Inflation – Quantity Theory of Money and Inflation (c) Keynesian Theory of Inflation (d) Concept of Inflationary Gap (e) Unemployment and Inflation – Stagflation (f) Demand pull and Cost push inflation – interaction between demand pull and cost push inflation (g) Measures of controlling inflation (h) Unemployment – Natural Rate of Unemployment (i) Philips Curve and NAIRU

	(j) Short and Long Run Philips Curve Unit 6: *Output, Price and Employment(2L)* (a) Supply of Output – Aggregate Production Function (b) Aggregate Demand for and Supply of Labour (c) Aggregate Supply Function – Relation between Aggregate Supply and Price (e) Shifts in Aggregate Demand and Supply Curve (g) Determination of Aggregate Output, Employment, Rate of Interest and Pr ice (h) Comparison of Keynesian and Classical Position – Aggregate Supply and Demand in Classical Theory (i) Neutrality of Money – Classical Dichotomy – Effects of Monetary and Fiscal Policy in Classical Framework Part 2: Management Accountancy Unit 1: INTRODUCTION TO ACCOUNTING (2L) Definition of Accountancy; Accounting vs. Book Keeping, Attributes of Accounting, Objectives of Accounting; Branches of Accounting, Users of Accounting Statements, Generally Accepted Accounting Principles (GAAP) Unit 2: Preparation of Trial Balance and Final accounts(8L) PRIMARY BOOKSOF ACCOUNTS (JOURNAL) Meaning of Journal, Format of Journals, Rules of Debit and Credit, Opening Entry, Simple and Compound entries, Numerical Problems SECONDARY BOOSOF ACCOUNTS (LEDGER) Meaning of Ledger, Formats of Ledgers, Ledger Posting, Numerical Problems Cash Book Nature of Cash Book, Different Types of Cash Books - Single Column, Double Column and Triple Column, Petty Cash Book Concept, Preparation of Trial Balance, Numerical Problems, Advantages and Limitations of Trial Balance Concepts, Procedure for the Preparation of Trading A/c, Profit and Loss A/c and Balance Sheet and different types of adjustments. Unit 3: Cost volume and profit analysis (4L)
Text Books, and/or reference material	**Text Books**: 1. Pindyck, R.S. &Rubenfeld, D. L.: Microeconomics, Pearson Education, Chapters 1, 2. 2.Varian, H. R.: Intermediate Microeconomics, EWP, Chapter 1. 3. N. G. Mankiw: Macroeconomics, Worth Publishers, Chapters 4, 6, 10 4. W. H. Branson: Macroeconomics – Theory and Policy (2nd ed), AITBS 5.Gupta, RL and Radhaswamy, M : Financial Accounting ; Sultan Chand and Sons 6.Ashoke Banerjee: Financial Accounting, Excel Books 7.Maheshwari:Introduction to Accounting,Vikas Publishing 8.Shukla, MC, Grewal TS, and Gupta, SC : Advanced Accounts; S. Chand & Co

COURSE ARTICULATION MATRIX

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	1	2	1	1	2	1	1	1	-	-	2	2	2	1
CO#2	3	2	2	1	1	2	1	1	1	-	-	1	2	1	1
CO#3	1	2	1	1	1	3	2	1	1	-	1	1	3	1	2
CO#4	2	3	2	2	1	1	1	1	1	-	1	2	2	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SIXTH SEMESTER

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 45</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECC601</td><td>Antenna and Wave Propagation</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Electromagnetic Theory and Transmission Lines (ECC403), Microwave Engineering (ECC 502)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1 Explain the concepts of antenna radiation patterns and various parameters for characterizing the antenna.
• CO2 Understand different modes of radio wave propagation.
• CO3 Classify various antennas on the basis of their electrical performances.
• CO4 Analyze various antennas and antenna arrays.
• CO5 Design antenna and antenna arrays for different applications.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I: (L – 2)
Antenna Basics: Definition and functions of an antenna, comparison between an antenna & transmission line, radio communication link with transmitting antenna and a receiving antenna, radiation mechanism, antenna types and their applications. [CO# 1] [T1,T2]
Module II: (L – 8)
Radiation from Electric Current Elements: Potential functions and the electromagnetic fields, Radiation from oscillating electric dipole, quarter wave monopole; Half wave dipole; derivations of E and H field components, far field pattern, radiation resistance, Power Radiated by a current element and its application to antennas, separation of field region, application of reciprocity theorem to antennas, directional properties of dipole antennas, antenna feeding methods. Folded dipole.[CO# 1, 4, 5] [T1,T3]
Module III: (L – 7)
Antenna Parameters: Radiation patterns, beam area, beam efficiency, beam width-Half-Power Beam width (HPBW) and First Null Beam width (FNBW), Polarisation, Radiation Intensity, Directivity and directive gain, radiation resistance, radiation efficiency, resolution, Antenna aperture - physical and effective apertures, effective height, transmission formula, Matching – Baluns, Polarization, Polarization mismatch, Antenna noise temperature, Transmission loss as a function of frequency, Antenna temperature and signal to noise ratio. [CO# 2, 4] [T1,T2]
Module IV: (L – 6)
Reflector, Slot and Horn antennas: Parabolic reflector, paraboloidal reflector, Geometry, Pattern Characteristics, aperture Pattern of large circular apertures with uniform illumination, off axis operation of paraboloidal reflectors, Feed Methods, Cassegrain feed system. Slot antenna, its pattern, Babinet's principle and complementary antennas, impedance of slot antennas, and horn antenna-function and types; Rectangular Horn, Septum Horn, Ridge Horn, Corrugated Horn, Aperture Matched Horn. [CO# 3, 4, 5] [T1, T2]
Module VI: (L – 4)
Microstrip Patch Antennas: Advantages and Limitations, Rectangular and circular types-function, features analysis, design considerations, Feeding methods, Method of</td></tr>
</table>

	analysis.[CO# 3, 4, 5] [T1] **Module VII: (L – 4)** **Antenna Arrays:** Point Sources – Definition, Patterns, arrays of two antennas – Different Cases, Principle of Pattern Multiplication, Derivation of array factor expression of Uniform Linear Array with N elements – Broadside Arrays (BSA), End fire Arrays (EFA), End fire array with Increased Directivity (EFAID), Phased Scanning Arrays, Direction of nulls and maxima, Beam-width, Comparison of BSA, EFA and EFAID characteristics. Arrays with Parasitic Elements, Yagi-Uda Array[CO# 4, 5] [T1, T2] **Module VIII: (L – 7)** **Loop, Helical and Broadband Antennas:** Introduction, Small Loop, Comparison of Far Fields of Small Loop and Short Dipole, Radiation Resistances and Directivities of Small Loops (Qualitative Analysis) Helical antenna: Helical Geometry, Helix Modes, Practical Design Considerations of Helical Antenna in Axial and Normal Modes, Broadband antenna, Frequency independent antenna, log periodic antennas. Antenna Measurements-Test Ranges, Measurement of Gain, Radiation pattern, Polarization, VSWR[CO# 4, 5] [T1, T2] **Module XII: (L – 7)** **Radio Wave Propagation:** Different Modes of Wave Propagation, Structure of atmosphere, Ground Wave Propagation (Qualitative Treatment) – Introduction, Plane Earth Reflections, Space and Surface Waves, Wave Tilt, Curved Earth Reflections. Space Wave Propagation – Introduction, Field Strength Variation with Distance and Height, Effect of Earth's Curvature, Absorption, Super Refraction, M-Curves and Duct Propagation, Scattering Phenomena, Tropospheric Propagation. Wave Propagation – Sky Wave Propagation – Introduction, Structure of Ionosphere, Refraction and Reflection of Sky Waves by Ionosphere, Ray Path, Critical Frequency, MUF, Virtual Height and Skip Distance, Relation between MUF and Skip Distance, Multi-hop Propagation[CO# 1, 2] [T3]
Text Books, and/or reference material	**Text Books**: [T1]. Balanis, Antenna Theory and Design, Wiley Publications [T2]. John D. Krauss, Antennas for all Applications, TMH. [T3]. Edward C.Jordan and Keith G.Balmain" Electromagnetic Waves and Radiating Systems" Prentice Hall of India. **Suggested Reference Books**: [R1]. R.E.Collin,"Antennas and Radiowave Propagation", McGraw Hill 1985. [R2]. Constantine.A.Balanis "Antenna Theory Analysis and Design", Wiley Student Edition, 2006. [R3]. Rajeswari Chatterjee, "Antenna Theory and Practice" Revised Second Edition New AgeInternational Publishers, 2006. [R4]. S. Drabowitch, "Modern Antennas" Second Edition, Springer Publications, 2007. [R5]. Robert S.Elliott "Antenna Theory and Design" Wiley Student Edition, 2006. [R6]. H.Sizun "Radio Wave Propagation for Telecommunication Applications", First Indian Reprint,Springer Publications, 2007.

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	1	2	1	1	2	1	1	1	-	-	2	2	2	1
CO#2	3	2	2	1	1	2	1	1	1	-	-	1	2	1	1
CO#3	3	3	1	1	1	-	-	-	-	-	-	1	3	1	1
CO#4	1	2	1	1	1	3	2	1	1	-	1	1	3	1	2

CO#5	2	3	2	2	1	1	1	1	1	-	1	2	2	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics & Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC602	VLSI Design	PCR	3	0	0	3	3
Pre-requisites			Course Assessment methods: (Continuous Assessment (CA:15%), Mid-Term Assessment (MA:25%) and End-Term Assessment (EA:60%))				
Digital Circuits and Systems (ECC402)			Continuous Assessment (CA): Quizzes/Class tests/Assignments/Attendance				

Course Outcomes	After successful completion of the course, the student will be able to: • **CO 1:** Acquire idea about the digital IC design techniques. • **CO 2:** Understand the characteristics of the CMOS inverter. • **CO 3:** Identify the basic steps of ASIC Design Flow and fabrication process. • **CO 4:** Analyze the static and dynamic characteristics of CMOS circuits. • **CO 5:** Design and implementation of combinational and sequential circuits. • **CO 6:** Evaluate the performance of CMOS circuits.
Topics Covered	**Module I. Overview of VLSI Design [L – 6]** Historical perspective, an overview of VLSI design methodologies, VLSI design flow, design hierarchy, concepts of regularity, modularity, and locality, VLSI design styles, design quality, packaging technology, CAD technology, Recent Trends in VLSI Design & its research issues in the industry: System case studies. Design automation of VLSI Systems: basic concepts. Deep Sub-micron Technologies: Some Design Issues. **Module II. MOS Transistor Theory [L – 4]** Introduction to The metal oxide semiconductor (MOS) structure, Long-channel I-V characteristics, C-V characteristics, non-linear I-V effects, DC transfer characteristics, sub-threshold swing in MOSFET, multi-Vt. **Module III. ASIC Design Flow [L – 6]** ASIC and SoC, Overview of ASIC flow, concepts of HDL coding, functional verification, RTL-GATE level synthesis, synthesis optimization techniques, pre-layout timing verification, static timing analysis, floor-planning, placement and routing, extraction, post-layout timing verification, extraction. **Module IV. CMOS Process Technology[L – 2]** Fabrication process flow- basic steps, the CMOS n-Well process, layout design rules, stick diagram, full-custom mask layout design. **Module V. MOS Inverter- Static Characteristics [L – 4]** Resistive-load inverter, inverter with n-type MOSFET load, CMOS inverter. **Module VI. MOS Inverters- Switching Characteristics & Interconnects effects [L-6]** Delay-time definitions, calculation of delay times, logical efforts, inverter design with delay constraints, estimation of interconnect parasitics, calculation of interconnect delay, Bus vs. Network-on-Chip (NoC), switching power dissipation of CMOS inverters. **Module VII. Combinational CMOS Logic Circuits[L – 7]** MOS logic circuits with depletion nMOS loads, CMOS logic circuits, complex logic circuits, CMOS transmission gates (pass gates), ratioed, dynamic and pass transistor logic circuits, domino circuits. **Module VIII. Sequential CMOS logic circuits [L – 7]**

	Behavior of bi-stable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch, and edge-triggered flip-flop. Timing path, Setup time and hold time static, the example of setup and hold time static, setup and hold slack, clock skew and jitter, Clock, reset, and power distributions.
Text Books, and/or Reference Material	**Text Books:** 1. N. H. E. Weste and C. Harris, "*Principles of CMOS VLSI Design: A System Perspective*", 3rd Edition, Pearson Education 2007. 2. Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim, "*CMOS Digital Integrated Circuits*", 4th edition, McGraw-Hill, 2018. **Reference Book:** 1. Jan M. Rabaey, AnanthaChandrakasan, BorivojeNikolic, "*Digital Integrated Circuits: A Design Perspective*", 2nd Edition, Pearson Education, 2009.

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#3	3	3	3	1	1	1	1	1	1	1	1	1	3	3	2
CO#4	1	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	2	3	1	2	1	2	2	1	1	1	1	1	2	3	2
CO#6	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 56				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC603	Digital Signal Processing	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT),End Assessment (EA))					
Signals and Systems (ECC303), Mathematics-II & III (MAC02, MAC331)		Class Assignments, Mid and End term examinations					
Course Outcomes	On successful completion of this course, students should have the skills and knowledge to: **CO1**. Represent signals in time and frequency domain. **CO2**. Implement DFT, FFT and z-transform. **CO3**. Analyse a given signal or system using tools such as Fourier transform and z-transform to know the property of a signal or system. **CO4**. Design of prototype of Linear Phase Filters, FIR and IIR Filter Structure. **CO5**. Process signals to make them more useful and to design a signal processor (Digital filter structures) for a given problem.						
Topics Covered/ Syllabus	Introduction: reasons behind digital processing of signals, brief historical development, organization of the course. (L=2) Theory of discrete time linear system sequences, linear time invariant systems, causality, stability, difference equations, frequency response, discrete Fourier series, relation between continuous and discrete systems, Inverse Systems, Stability. (L=2, T=1)						

	Z –transform: definition, properties of Z transform, system function, digital filter implementation from the system function, region of convergence in the Z plane, determining filter coefficients from the singularity locations, geometric evolution of Z transform in the Z plane, relationship between Fourier transform and Z transform, inverse Z transform. (L=4, T=1) Transform technique: Fourier transform, its properties, inverse Fourier transform, discrete Fourier transform, properties of DFT, circular convolution, computations for evaluating the DFT, decimation in time and decimation in frequency FFT algorithms, discrete Hilbert transform. (L=5, T=2) Digital filter structures: system describing equations, filter categories, All Pass Filters, Comb Filters, direct form I and II structures, cascade and parallel communication of second order systems, Polyphase representation of filters, linear phase FIR filter structures, Compensatory Transfer Functions, frequency sampling structure for the FIR filter. Test for Stability using All Pass Functions. (L=6, T=2) IIR filter design techniques: Analog Filter Design, Analog Butterworth lowpass filter design techniques, Analog Chebyshev LPF, Design methods to convert analog filters into digital filters, frequency transformation for converting lowpass filters into other types, all-pass filters for phase response compensation. (L=6, T=2) Digital Filter Structures: IIR Realizations, All Pass Realizations, FIR and IIR Lattice Synthesis, IIR Design by Bilinear Transformation, Digital to Digital Frequency Transformation. (L=6, T=2) FIR filter design techniques: Windowing method for designing FIR filters, DFT method for approximating the desired unit sample response, combining DFT and window method for designing FIR filter, frequency sampling method for designing FIR filter (L=6, T=2) Non-Linear System Identification Schemes, Fractional-order digital differentiators (DDs) and digital integrators (DIs), Fractional-order low-pass Butterworth and Chebyshev filter. (L=5, T=2)
Text Books, and/or Reference material	**Text Books**: 1) Discrete-Time Signal Processing (Second Edition), Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck, Pearson Education India 2) Digital Signal Processing: Principles, Algorithms and Applications (3rd Edition), John G. Proakis, Dimitris G. Manolakis, and D Sharma, Pearson Education India 3) Richard G. Lyons, Understanding Digital Signal Processing, Prentice Hall, 1996. ISBN:0201634678. 4) Digital Signal Processing by Tarun Kumar Rawat, Oxford University Press, ISBN: 9780198081937
	Reference Books/materials: 1) S. W. Smith, The Scientist and Engineer's and Guide to Digital Signal Processing, California Technical Publishing, 1997. ISBN: 0-9660176-3. 2) Digital Signal Processing using MATLAB, Vinay K. Ingle, John G. Proakis, Brooks/Cole-Thomson Learning

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	2	1	-	-	-	-	-	-	2	3	1	1
CO#2	3	3	2	2	2	-	-	-	-	-	-	3	3	1	1
CO#3	3	3	2	3	2	-	-	-	-	-	-	3	3	3	1
CO#4	3	3	3	3	2	-	-	1	-	-	-	3	3	3	2
CO#5	3	2	3	3	2	1	-	-	-	-	-	2	3	3	2

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 27				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS651	Antenna and Wave Propagation Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
Electromagnetic Theory and Transmission Lines (ECC403) and Microwave Engineering (ECC 502), Microwave Engineering Lab (ECS552)		Day to day evaluation during the laboratory session and End Semester Examination					
Course Outcomes	After successful completion of this course, the students will be able to CO#1: Understand theory of EM wave propagation and power transmission through free space medium. CO#2: Compare the radiation characteristics of different antenna and antenna arrays CO#3: Analyze the radiation characteristics of different antennas in terms of their radiation parameters. CO#4: Use of VNA to study antenna characteristics. CO#5: Identify the suitable antenna for the application different communication systems. CO#6: Design a particular antenna as per the requirements of given specifications.						
List of Experiments	7. To plot the radiation pattern of half wave dipole antennas. 8. To plot the radiation pattern of half wave monopole antenna. 9. To plot the radiation pattern of half wave folded dipole antenna. 10. To study the radiation characteristics of Yagi-Uda antenna. 11. To the radiation characteristics of log periodic dipole antenna 12. To plot the radiation pattern of microstrip patch and slot antennas 13. Measurement of return loss of a given antenna using Network Analyzer 14. Study of radiation pattern of Horn antenna and understand the Friis transmission equation 15. To observe the characteristics of microstrip antenna using EM simulation software.						
Text Books, and/or reference material	**Reference Materials:** [T4]. Laboratory Instruction Manual and Operation Manual of the Manufacturer [T5]. http://www.electronics-tutorial.net/lab-test-and-measurement/Antenna-and-Wave-Propagation/Exp-9/ [T6]. Balanis, Antenna Theory and Design, Wiley Publications						

COURSE ARTICULATION MATRIX

Mapping CO (Course outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome):

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	2	1	1	-	-	-	-	1	1	-	1	3	2	2
CO#2	3	2	1	1	-	-	-	-	1	1	-	1	2	1	1

CO#3	3	2	1	1	-	-	-	1	1	1	-	1	3	3	2
CO#4	3	2	2	1	1	-	-	-	1	1	1	1	3	3	2
CO#5	3	2	2	2	1	-	-	-	1	1	-	1	3	1	1
CO#6	3	3	3	1	-	-	-	-	1	1	-	1	2	3	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 30</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS652</td><td>VLSI Design Lab</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="4">Course Assessment methods
(Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic Electronics (ECC01), Physics of Semiconductor Devices (PHC331), and Digital Circuits and Systems (ECC402)</td><td colspan="4">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">● CO1: Understanding of HDL coding and simulation using EDA tools
● CO2: Analyze the combinational circuits
● CO3: Analyze the sequential circuits
● CO4: Design and implementation of combinational circuits
● CO5: Design and implementation of sequential circuits</td></tr>
<tr><td>Topics Covered</td><td colspan="6">List of experiments
1. Design and Implementation of combinational circuits using data flow or gate-levelmodeling along with their test bench
I. Basic Gates (CO#2, CO#4)
II. Half-Adder and Full-Adder (CO#2, CO#4)
III. Half-Subtractor and Full-Subtractor (CO#2, CO#4)
IV. 2:4 Decoder (CO#2, CO#4)
V. 8:3 Encoder (CO#2, CO#4)
VI. Parity Checker (CO#2, CO#4)
VII. 8:1 Multiplexer (CO#2, CO#4)
VIII. 1:4 De-multiplexer (CO#2, CO#4)
IX. Binary to gray converter (CO#2, CO#4)
X. Gray to binary converter (CO#2, CO#4)
XI. 2-bit magnitude comparator (CO#2, CO#4)
2. Design and Implementation of sequential circuits along with their test bench
I. Design and simulation of Flip-flops (RS FF, JK FF, T FF, D FF& Master-slave FF) using VHDL\ Verilog (CO#1, CO#3, CO#5)
II. Design and simulation of Counters (Synchronous and Asynchronous) using VHDL\ Verilog. (CO#1, CO#3, CO#5)
III. Design and Simulation of Shift registers (SISO, SIPO, PISO & PIPO) using VHDL\ Verilog. (CO#1, CO#3, CO#5)
IV. Design an Arithmetic unit using VHDL\ Verilog. (CO#1, CO#3, CO#5)
3. Spec. to GDSII using QFlow chains
<u>Specifications</u>: Two counters – one clocked by an external clock, the other by</td></tr>
</table>

	an internally generated clock. All clocks have to be identified for static timing to work correctly. Total 40 flip-flips are nowhere near the limit in terms of area for this chip size. Only four outputs and two inputs, power, and ground. The total is 8 pins. (CO#1, CO#3, CO#5)
Text Books, and/or reference material	**Text Book**: 1.Samir Palnitkar, "Verilog HDL," Second Edition, Pearson education 2003

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	2	2	2	1	1	1	1	1	1	1	1	2	3	2
CO#2	2	2	2	2	3	1	1	1	1	1	1	1	2	3	2
CO#3	2	2	2	2	3	1	1	1	1	1	1	1	2	3	2
CO#4	2	2	2	2	3	1	1	1	1	1	1	1	2	3	2
CO#5	2	2	2	2	3	1	1	1	1	1	1	1	2	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 30				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS653	Digital Signal Processing Lab	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
MATLAB, Signals & Systems (ECC 303)		Quizzes and Lab Assessments					
Course Outcomes	On completion of the experiments conducted, students will be able to: CO#1: Generate different types of digital signals CO#2: Sampling, reconstruction, linear and circular convolution between signals CO#3: Simulate impulse response of systems from difference equations CO#4: Study the frequency response of LTI systems CO#5: Carry out Discrete Fourier Transform and Fast Fourier Transform CO#6: Design different Digital Filters						
Topics Covered/ Syllabus	***A. Introduction to digital signals and systems:*** **Experiment 1:** Generate and plot the following sequences: i. Unit sample sequence ii. Unit step sequence iii. Unit ramp sequence iv. Real valued exponential sequence $x(n)=(0.8)^n u(n); 0 \le n \le 50$ v. Square wave and Sawtooth wave sequence of length 50, having peak						

amplitude 5.

Experiment 2:

a) Generate a 50 Hz continuous time sinusoidal signal $x(t) = A\cos(2\pi ft)$ having frequency of 50 Hz and its sampled version with sampling frequency 1000 Hz. Assume the amplitude as 5.

b) Write a program to generate a signal $x(n) = u(n) - u(n-10)$. Also plot the even and odd component of the signal.

B. Sampling, reconstruction and convolution of signals:

Experiment 3:

Consider an analog signal $x(t) = \sin(20\pi t); 0 \le t \le 1$. It is sampled at sampling time interval (T_s) as 0.01 second to obtain $x(nT_s)$. Reconstruct the analog signal from the sampled signal using *sinc* interpolation.

Experiment 4:

a) Evaluate the convolution sum for a system whose impulse response $h(n)$ and input $x(n)$ are same and are described as:

$$x(n) = h(n) = \left[u(n+N) - u(n-N-1)\right]$$

b) Find the linear convolution of the following signals:

$x(n) = \{2, \underset{\uparrow}{1}, 3, 5, 9\}$ and $h(n) = \{5, \underset{\uparrow}{5}, 8, 9, 2\}$

c) Write down a program to compute the correlation of the following sequence.

$x(n) = \{\underset{\uparrow}{1}, 4, 1, 3\}$

C. Difference equation and impulse response:

Experiment 5:

a) Find the impulse response of the following system: y(n) -0.6y(n-1) +0.08y(n-2) = x(n)

b) Find the step response of the system y(n)=0.7y(n-1)-0.12y(n-2)+x(n-1)+x(n-2) with the initial condition y(-1)=1,y(-2)=1.

c) An LTI system is specified by the difference equation y(n) = 0.8y(n-1) + x(n) Determine H(e^{jw}). Also calculate and plot the steady state response for the input x(n) = cos(0.05πn)u(n)

D. Frequency domain transforms:

Experiment 6:

d) A symmetrical rectangular pulse is given by

$$x(n) = 1; -N \le n \le N$$
$$0; \text{otherwise}$$

Determine the DTFT for N=2, 5, 10, 15. Scale the DTFT so that $X(e^{j0}) = 1$. Plot the normalized magnitude response of the DTFT over $[-\pi, \pi]$, Study these plot and comment on their as a function of N.

e) Determine and plot the DTFT of a sinusoidal signal $x(n) = \cos\left(\frac{\pi n}{4}\right); 0 \le n \le 100$. Also investigate the periodicity.

Experiment 7:

a) A discrete time LTI system is represented by a first order difference equation $y(n)=ay(n-1)+x(n);n\geq 0$ where $x(n)$ is the input of the system and $y(n)$ is the corresponding output. For an input $x(n)=u(n)-u(n-1)$, zero initial condition and $a=0.8$, find and plot $y(n)$.

Given a causal system $y(n)=0.9y(n-1)+x(n)$, find $H(z)$ and plot its poles and zeros. Also plot the frequency response $\left|H(e^{jw})\right|$ and $\angle H(e^{jw})$.

E. Discrete Fourier Transform and Fast Fourier Transform:

Experiment 8:

a) Consider a 9-point sequence $x(n)=\{1,2,3,4,5,6,7,8,9\}$. Determine and plot the sequences $x\langle\langle n-3\rangle_9\rangle$ and $x\langle\langle n+3\rangle_9\rangle$.

b) Let $x_1(n)=\{1,2,2,1\}$ and $x_2(n)=\{1,2,3,4\}$ .Write a program to perform 4-point circular convolution of these two signals. Also find the linear convolution of these two signals using circular convolution.

Experiment 9:

Compute the output of a linear filter described by impulse response $h(n)=\{1,2,3,1,2\}$ and input $x(n)=\{1,1,1,1\}$ using fft command.

F. Digital Filters:

Experiment 10:

a) For the desired frequency response

$$H_d(e^{j\omega})=e^{-j\omega\tau};\omega_{c1}\leq|\omega|\leq\omega_{c2}$$
$$0;|\omega|<\omega_{c1},\omega_{c2}<|\omega|\leq\pi$$

Determine $H(e^{j\omega})$ for M=35 using Blackman window if $\omega_{c1}=\frac{\pi}{4}$ and $\omega_{c2}=\frac{\pi}{2}$.

b) Implement type 1, 2, 3, 4 linear phase FIR filter.

Experiment 11:

a) Write a MATLAB program to design an IIR low pass Butterworth filter using the impulse invariant method for the following specifications:

$$0.8\leq\left|H(e^{j\omega})\right|\leq 1;|\omega|\leq 0.2\pi$$
$$\left|H(e^{j\omega})\right|\leq 0.2;0.6\pi\leq|\omega|\leq\pi$$

Assume T=1 second.

b) Write a MATLAB program to design a digital low pass Butterworth filter to satisfy the following specifications:

Pass band cutoff=0.2π, pass band attenuation= 7 dB, stop band cutoff= 0.3π, stop band attenuation= 16 dB using Bilinear Transformation method. Assume T= 1 second.

Text Books, and/or Reference material	**Text Books:** 1) Discrete-Time Signal Processing (Second Edition), Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck, Pearson Education India 2) Digital Signal Processing by Tarun Kumar Rawat, Oxford University Press, ISBN: 9780198081937

	Reference Books/Materials: 1) Digital Signal Processing using MATLAB, Vinay K. Ingle, John G. Proakis, Brooks/Cole-Thomson Learning

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	2	-	-	-	-	-	1	-	2	3	1	1
CO#2	3	3	3	2	-	-	-	-	-	1	-	1	3	1	1
CO#3	3	3	2	3	2	-	-	-	-	1	-	1	3	3	1
CO#4	3	3	2	3	2	-	-	-	-	1	-	1	3	3	2
CO#5	3	3	3	1	1	-	-	-	1	1	-	2	3	2	1
CO#6															

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE610	Artificial Intelligence and Soft Computing	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: Continuous (CT), mid-term (MT) and End Assessment (EA)					
Introduction to Computing (CSC01) & Computer Programming Languages like Python, C++, Matlab etc.		CT+MT+EA					
Course Outcomes	After the completion of the course the student will be able to learn the following: •CO1: Basics of optimization and soft computing algorithms •CO2: Learn different soft computing algorithms •CO3: Learn artificial neural network and its training •CO4: Study of radial basis function neural and its training •CO5: Study of machine learning algorithms and clustering						
Topics Covered	**Module I.Introduction to Optimization and soft computing algorithms** [L-8] Introduction to optimization, Constrained and unconstrained optimization, Introduction to Optimization based on soft computing, Genetic algorithms, particle swarm optimization **Module II.Review of different soft computing algorithms part-I** [L-7] Flower pollination algorithm, Teaching learning based optimization **Module III.Review of different soft computing algorithms part-II** [L-5] Crow search algorithm, Quantum Particle swarm optimization **Module IV.Basics of artificial neural network and its training** [L-7] Introduction to artificial neural network, Supervised Learning Neural Networks, Perceptrons, Adaline, Multilayer feed forward neural network, Training of neural network using backpropagation algorithm						

	Module V. Radial basis function neural networks and K-means clustering [L-5] Radial Basis Function Neural Networks (RBF), Training of RBF using pseudo inverse technique ,Data clustering using K-means **Module VI.Study of machine learning algorithms** [L-10] Extreme learning machine (ELM), Training and testing of ELM, Recurrent Neural Network(RNN) and long short-term memory (LSTM),Training a LSTM based RNN, Deep learning and Convolutional Neural Network(CNN).
Text Books, and/or Reference material	**Text Books**: 1.S N Sivanandam, S.N.Deepa, "Principles of Soft Computing," Wiley,3rd edition,2018 2.Samir Roy &Udit Chakraborty, "Introduction to Soft Computing," Pearson,1st edition,2013 3.Satish Kumar, " Neural Networks: A Classroom Approach",McGraw-Hill (India), 2013 4.Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms, "Cambridge University Press",2014
	Reference books: 1.S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI,2003 2.Jang, Sun, Mizutani, "Neuro-Fuzzy and Soft computing", Pearson,2015 3.Simon Haykin, "Neural networks and learning machines," Pearson,3rd edition,2009 4.Charu C.Aggarwal, "Neural Networks and Deep learning,"Springer,2018

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	1	1	2	1	1	1	1	1	1	2	3	2
CO#2	3	3	3	2	2	2	1	1	1	1	1	1	3	2	2
CO#3	3	3	2	2	2	1	2	1	1	1	1	1	3	3	2
CO#4	3	2	2	3	3	2	1	1	1	1	1	1	3	3	2
CO#5	3	2	2	2	2	2	1	1	1	1	1	1	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE611	Computer Organization and Architecture	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
Digital Circuits and Systems (ECC402), Microprocessors and Microcontrollers (ECC503)		The assessment methods comprise of quizzes, multiple choice type questions, and subjective questions all either designed in google form or assessed through pen and paper.					

Course Outcomes	After successful completion of the course, the student will be able to: ● **CO 1:**Acquire idea about computer architecture and organization. ● **CO 2:**Understand the fundamental concepts of ISA. ● **CO 3:**Illustrate the operations of the memory unit. ● **CO 4:**Analyzethe control and data flow of a computer. ● **CO 5:**Design and implementation of multiprocessors. ● **CO 6:** Evaluate the performance of a computer system.
Topics Covered	**Module I. Introduction and Basics [L – 4]** History of computers, introduction to computer architecture, level of transformation, abstract layers, their benefits of comfortably crossing them, instruction set architecture I, instruction set architecture II, instruction set architecture III, architecture examples, example problem, and solution ideas. **Module II. Fundamental Concepts and ISA [L – 6]** Fundamental concepts in computer architecture: Von Neumann model and data flow model, ISA principles and trade-off, elements of an ISA, RISC vs. CISC, MIPS ISA, ISA vs. microarchitecture level trade-off, property of ISA vs. microarchitecture. **Module III. Arithmetic Operations [L – 5]** Binary arithmetic, ALU Design, multiplier design, divider design, fast addition, multiplication, floating-point arithmetic. **Module IV. Processor Design [L – 8]** Single-cycle microarchitecture, multi-cycle microarchitecture, microprogrammed microarchitecture, pipelining: issues in pipelining, data and control dependence handling, branch prediction, precise exceptions, state maintenance, state recovery; Out-of-Order execution and issues in OoO execution. **Module V. SIMD, GPUs, VLEW and DAE [L – 5]** SIMD processing: array and vector processors, SIMD operation in modern ISAs, VLIW, Decoupled Access Execute (DAE), Systolic Array. **Module VI. Memory Hierarchy and Caches [L - 7]** Memory hierarchy, physical memory and virtual memory, emerging memory technologies, main memory, memory controller, memory management, memory latency tolerance: prefetching, Cache organization and operation, high-performance caches, memory consistency, and cache coherence, in-memory processing **Module VII. Multiprocessor [L – 7]** Multiprocessor types, multiprocessing, and issues in multiprocessor, limits of parallel speedup, difficulty in parallel programming, heterogeneous systems, input/output subsystem, interfaces, I/O operations, interconnection networks: bus-based and NoC based architectures.
Text Books, and/or reference material	**Text Books:** 1. Patterson and Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, 4th Edition, Morgan Kaufmann/ Elsevier, 2009. 2. W. Stallings, “Computer architecture and organization: Designing for Performance” Pearson Education; 9th edition (1 January 2013) **Reference Books:** 1. Andrew Tanenbaum, “Structured Computer Organization”6th Ed, Pearson, 2016. 2. Patt and Patel, “Introduction to Computing Systems: From Bits and Gates to C and Beyond”, Morgan Kaufman, Elsevier, 2th Edition, McGraw-Hill Education 2003. 3. Harvey Cragon, “Computer Architecture and Implementation”, Cambridge University Press, 2000. 4. C. Hamacher, Z. Vranesic, S. Zaky, “Computer Organization”, McGraw Hill Education; 5th Edition, 2011.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)														
PO/PSO CO	**PO# 1**	**PO# 2**	**PO# 3**	**PO# 4**	**PO# 5**	**PO# 6**	**PO# 7**	**PO# 8**	**PO #9**	**PO# 10**	**PO# 11**	**PO# 12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	3	3	3	2	1	2	1	1	1	1	1	1	3	3	2
CO#2	3	2	2	2	1	2	1	1	1	1	1	1	3	2	1
CO#3	3	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	3	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#6	3	2	2	2	1	2	1	1	1	1	1	1	3	2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE612	Advanced Digital Communication	PEL	3	0	0	3	3
Pre-requisites		Continuous Assessments: Class Assessment (CA), Mid-Sem (MA) and End-Sem assessment (EA)					
Signals and Systems (ECC303), Analog Communication (ECC401), Digital Communication (ECC501), Probability Theory for Engineering Application (ECO541) / any other equivalent subject from SWAYAM, NPTEL,etc.		(CA-15) +(MA-25) + (EA-60)					
Course Outcomes	• CO1: **Identify** the fundamental differences between analog and digital communication systems and the explicit need to study digital communication as a separate course. **Identify** building blocks that constitute a digital communication system. • CO2: **Explain** why each building block is necessary and the working principle of each such block. • CO3: **Apply** geometric concepts to understand signal constellations and its variants. **Apply** signal processing tools to infer time and frequency domain representation of signals in context to digital communications. • CO4: **Analyze** error performance of digital communication systems in the presence of additive noise. • CO5: **Evaluate and access** communication systems based on resource availability (bandwidth, power, etc.) and performance requirement (BER, SER, etc.). • CO6: **Develop** strong mathematical foundation and intuition to **pursue any advanced topic in communications** (wireless communication, detection and estimation theory, etc.).						

Topics Covered	1. **Introduction** **(1 hr.)** 2. **Module-1** **(3 hrs.)** Review of Autocorrelation, Cross correlation**,** Energy Spectral Density (ESD) and Power Spectral Density (PSD) **3. Module-2 :(3 hrs.)** Complex baseband representation of real bandpass signals, real bandpass LTI systems **4. Module-3 :(3 hrs.)** Digital communication through band-limited channels **5. Module-4 : (3 hrs.)** Signal Space and Signal Vector : Geometrical representation of signals **6. Module-5 : (7 hrs.)** Optimum receivers for AWGN channels: Maximum likelihood decoding of M-ary signals – Correlation receiver and Matched filter receiver, SER and BER **7. Module-6 :(5 hrs.)** Basics of Detection and Estimation theory **8. Module-7 : (5 hrs.)** Advanced modulation technique : Coherent and noncoherent modulation, MSK, M-arymodulation techniques (QPSK, QAM etc.) **9. Module-8 : (6 hrs.)** Spread spectrum for digital communications : Pseudo-Noise Sequence, Direct-Sequence Spread Spectrum, Frequency-Hop Spread Spectrum, Slow FHSS, Fast FHSS, Applications of Spread Spectrum **10. Module-9 :(6 hrs.)** Multichannel communications and OFDM : Principle of OFDM, Multicarrier modulation technique, FFT/IFFT and OFDM, OFDM transmitter, OFDM receiver, BER performance of OFDMsystem
Text Books, and/or reference material	**Text Books**: 1. S. Haykin, “Digital Communication Systems” , Feb 2013, John Willey 2. J. G. Proakis and M. Salehi “Digital Communications”, 2014 (6th edition), McGrawhill 3. Bernard Sklar, “Digital Communications” (2th edition), Pearson Education **Reference Books**: 1. NOC : “Modern Digital Communication Techniques”, Prof. SuvraSekhar Das, IIT Kharagpur, URL : https://nptel.ac.in/courses/117/105/117105144/ 2. Richard van Nee &Ramjee Prasad “OFDM for Multimedia Communications”, Artech House

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	2	2	2	2	1	1	1	1	1	1	1	3	2	1
CO#2	2	2	2	2	2	1	1	1	1	1	1	1	3	2	1
CO#3	3	3	3	3	2	1	1	2	1	1	1	1	3	3	1
CO#4	3	3	3	3	2	1	1	2	1	1	1	1	3	3	1
CO#5	3	3	3	3	2	1	1	2	1	1	1	1	3	3	1
CO#6	2	2	2	1	1	1	1	1	1	1	1	1	2	2	1

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<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE613</td><td>Object Oriented Programming</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods
(Continuous (CT), Mid-Term (MT),End Assessment (EA))</td></tr>
<tr><td colspan="2">Introduction to Computing (CSC01)</td><td colspan="6">The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: Implement programs using classes and objects
CO2: Specify the forms of inheritance and use them in programs
CO3: Analyze polymorphic behavior of objects
CO4: Introduce Templates and Exception Handling
CO5: Design and write programs using an object oriented language
CO6: Apply object oriented approach to design software</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Overview-[3L]
Programming in general; Programming paradigms-Procedural, Functional, Logic and Object Oriented; Basics of Object Oriented Programming; Available Object Oriented Languages; Program Compilation; Object Oriented Programming Terms – Class, Object, Encapsulation, Abstraction, Polymorphism, Inheritance, Static and Dynamic Binding.
Revisiting Array, Pointer and Structure – [2L]
Defining arrays and accessing array elements; Array initialization and assigning values to array elements; Multidimensional arrays; Addresses and Pointers; Void pointer, address-of and indirection operator; Pointer to pointers; Difference of Pointer and Array; Pointer arithmetic; Defining structures
Revisiting Functions- [2L]
Declaration, definition and call of a function; Inline functions; Main function arguments; Reference variables; Function overloading; Parameter passing concepts- call by value vs. call by reference; Concept of recursion; Scopes of variables; Return from functions by value as well as by reference; Pointer to functions.
Data Abstraction through Classes and User Defined Data Types- [4L]
C-struct and defining user defined data types through typedef; Class, Object, and members of a class; Constructor and Destructor; Dynamic memory management using new and delete operator (C++) ormalloc and free (C-way); this operator; Static members of a class; Additional scope of variables.
Operator Overloading-[4L]
Operator overloading techniques and restrictions; Overloading unary and binary operators; Overloading function operator, index operator, class member access, and cast operator; User defined conversions through constructors or cast operators; Overloaded non-member operators outside the class; Overloading new and delete operators.
Class Relationships– [4L]
The concept of inheritance- single and multiple; Constructor and Destructor calling sequences; Virtual base class; Accessibility in friends and derived classes; Virtual function and operator; Linking C file in C++ program.
Advanced Concepts – [4L]
Concept of template- class and function templates; Namespace; Need and mechanism of exception handling; Advanced cast operators- static_cast, dynamic_cast, reinterpret_cast, and</td></tr>
</table>

	const_cast; *typeid* operator **Standard Library in C++- [4L]** Standard C++ library functions for input and output handling; Standard Template Library **Data Structures and Applications in C++ - [4L]** Several fundamentally used data structures as array and linked list where from other data structures like stack, queue, tree, can be made **Object Oriented Design and Modelling–[4L]** Software development process from software engineering and quality perspective; Software architecture concepts; Best practices of software development; Phases of software development- inception, elaboration, construction, and transition; Object Oriented principles and concepts; Object Oriented modelling from views of Booch, Rumbaugh, Jacobson **Unified Modelling Language – [4L]** Basic building blocks of UML; Use case and actors; Structural and behavioural modelling aspects; Packaging and deployment; Software development process through UML. **Laboratory Workouts** – [**3L**]
Text Books, and/or reference material	**Text Books**: 1. BjarneStroustrup "The C++ Programming Language", Pearson Education 2. Debasish Jana, "C++ and Object Oriented Programming Paradigm", Prentice Hall of India Pvt. Ltd. **Reference Books**: 1. Bruce Eckel, "Thinking in C++", Prentice Hall 2. S. B. Lippman, J. Lajoie, B. E. Moo, "C++ Primer", Addison-Wesley Professional 3. BjarneStroustrup, "Programming: Principles and Practice Using C++", Addison-Wesley Professional 4. Effective C++: 50 Specific Ways to Improve Your Programs and Design by Scott Meyers, 1997

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) and PO (Programme Outcome)& PSO

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	1	1	2	1	3	1	1	1
CO2	2	3	2	3	1	1	1	1	1	2	1	3	2	1	1
CO3	2	3	2	3	1	1	2	1	1	1	1	3	2	1	1
CO4	3	2	2	2	1	1	2	1	1	1	1	3	2	1	1
CO5	3	3	3	3	1	1	2	1	2	3	1	3	1	1	1
CO6	3	2	3	3	3	1	2	1	2	3	2	3	1	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics & Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR)/ Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE614</td><td>ASIC Design using Verilog/VHDL</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous Assessment (CA:15%), Mid-Term Assessment (MA:25%) and End-Term Assessment (EA:60%))</td></tr>
<tr><td colspan="3">Digital Circuits and Systems (ECC402)</td><td colspan="5">Continuous Assessment (CA): Quizzes/Class tests/Assignments/Attendance</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After successful completion of the course, the student will be able to:
• CO 1: Explain VLSI design flow using HDL.
• CO 2: Analyze and design combinational and sequential digital systems.
• CO 3: Employ EDA tools to model a digital system.
• CO 4: Write test benches to verify the design.
• CO 5: Compare between blocking and non-blocking statement and their uses.
• CO 6: Create a System from simulation to synthesizable design.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I. Brief introduction to VLSI using CAD tools [L - 3]
Overview of Digital Design with Verilog HDL: Evolution of CAD, the emergence of HDLs, typical HDL-based design flow, Verilog HDL, Trends in HDLs.
Module-II.Hierarchical Modeling Concepts [L – 3]
Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block.
Module-III. Basic Concepts [L – 3]
Lexical conventions, data types, system tasks, compiler directives.Memory modeling Logic Synthesis: Introduction synthesis of different Verilog constructs.
Module-IV. Modules and Ports [L – 3]
Module definition, port declaration, connecting ports, hierarchical name referencing.
Module-V. Gate-Level Modeling [L – 2]
Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays.
Module-VI. Dataflow Modeling [L – 3]
Continuous assignments, delay specification, expressions, operators, operands, operator types.
Module-VII. Behavioural Modeling [L – 3]
Structured procedures, initial and always, blocking and nonblocking statements, delay control, generate a statement, event control, conditional statements, multiway branching, loops, sequential and parallel blocks
Module-VIII. Tasks and Functions [L – 4]
Differences between tasks and functions, declaration, invocation, automatic tasks, and functions.
Module-IX. Useful Modeling Techniques [L – 4]
Procedural continuous assignments, overriding parameters, conditional compilation and execution, useful system tasks.
Module-X. Flip-Flop and Counter Design [L – 4]
Synchronous and asynchronous flip flop design with set and reset, design of basic counters.
Module-XI. FSM & Processor Design [L – 6]
FSM modeling, Data path and Controller design, Modeling Memory, Pipelining, and Design of a Processor. Introduction to Reconfigurable computing, FPGAs, the Altera /Xilinx flow.
Module-XII. Essential System Verilog for UVM [L – 4]</td></tr>
</table>

	Overview of basic SystemVerilog, UVM verification environment: introduction to UVM methodology and universal Verification Components (UVC) structure, stimulus modeling, creating a simple environment, DUT, TLM, functional coverage modeling, register modeling in UVM.
Text Books, and/or Reference Material	**Text Books:** 1. Samir Palnitkar, "*Verilog HDL,A Guide to Digital Design and Synthesis*", Second Edition, Pearson Education, 2004 2. J. Bhaskar, "*Verilog HDL Synthesis*", BS publications, 2001. **Reference Books/Materials:** 1. S. Brown and Z. Vranesic, Fundamentals of Digital Logic with Verilog Design, McGraw Hill, Third Edition 2013. 2. G. De Micheli. Synthesis and optimization of digital circuits, McGraw Hill, 2003 3. IndranilSengupta, IIT Kharagpur, "*NPTEL Course on Hardware Modeling using Verilog*" (2017) https://www.youtube.com/watch?v=NCrlyaXMAn8&list=PLRsFfXmDi9IYCNlvNjrsD8bLMmNE0UxBH

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	1	3	2	1	1	1	1	1	1	1	1	1	2	3	1
CO#2	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#3	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#4	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#5	1	1	3	2	1	1	1	1	1	1	1	1	2	3	1
CO#6	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1

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Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE615	Active Filter Design	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT),End Assessment (EA))					
Electronic Devices and Circuits I (ECC302), Signal and Systems (ECC303)		Class Assignments, Mid and End term examinations					
Course Outcomes		After the completion of the course, the student will be able to: • CO1: Explain the operation of various High performance filters. • CO2: Design Analog Circuits. • CO3: Create the Layout of filters. • CO4: Analyze the performance of different active filters. • CO5: Interpret the use of Analog filter • CO6: Compare the architectures based on Area/Power/Speed.					

Topics Covered/ Syllabus	**Module-I:**[L-5] Introduction, Butterworth approximation, Chebyshev approximation, Inverse Chebyshev approximation, Synthesis of doubly terminated all-pole LC ladders filters, Synthesis of doubly terminated LC ladders with finite zeros of transmission. **Module-II:** Network sensitivity - low sensitivity of doubly terminated ladders, Introduction to frequency transformations, Properties of the driving impedance of lossless LC networks, Tellegen's theorem and positive real functions, Low Pass-to-Low Pass, Low Pass-to-Band Pass, Low Pass-to-High Pass and Low Pass-to-Band Stop transformations, Richard's Transformation, RC-CR transformation, Emulation of an inductor with a capacitor and controlled sources, the gyrator, a second order transconductor capacitor filter. [L-8] **Module-III:** Cascade of biquads realization of high order low pass filters, equivalence of the parallel RLC and series RLC circuits. Dynamic Range in active filters - impedance scaling and its effect on dynamic range, Introduction to noise in electrical networks, node scaling, Dynamic range scaling in active filters. [L-7] **Module-IV:** Biquad Ordering, Active Ladder Emulation / Leapfrog Filters, Effect of Transconductor non idelaities (parasitic capacitance/output resistance), parasitic poles, Effect of Finite Gain of the Transconductor. [L-5] **Module-V:** Single-ended Versus Differential Filters, Introducing the Differential-pair Based Fully Differential Transconductor, the Need for Common-mode Feedback, Stability of the Common-mode Feedback Loop, Common-mode Positive Feedback in Gyrators, Noise in the Differential Pair, Linearity of the Differential Pair, Cascoding, Noise in Cascodes, Layout Considerations and Multi-finger Transistors. Linearizing the Differential Pair, Resistive Degeneration. [L-7] **Module-VI:** Noise in Degenerated Transconductors, The Folded Cascode and Noise Analysis, Stabilizing filter bandwidth over process and temperature - the resistor servo loop, master-slave loops, Turning the filter into a VCO to estimate center frequency, example of a practical precision fixed-gm bias circuit, Introduction to accurate measurement and characterization techniques for active filters, Introduction to Active-RC filters, the use of an OTA instead of an opamp, swing and noise considerations, single stage OTAs, Multistage OTAs for use in CMOS Active-RC filters, The Miller compensated opamp in active-RC filters, noise considerations, noise in active-RC filters, Distortion and Intermodulation in filters, fixed gm-bias circuits [L-10]
Text Books, and/or Reference material	**Text Book**: 1. R Schaumann and M E Van Valkenburg, “Design of analog filters”, First Edition, Oxford University Press, 2005.
	Reference Books: 1. G Daryanani, “Principles of active network synthesis and design”, New York, Wiley, 1976. 2. M Van Valkenburg, “Analog filter design”, New York, Holt Rinehart and Winston, 1982. 3. Franco S., “Design with operational amplifiers and analog integrated circuits”, 3rd ed. New York, McGraw-Hill, 2002. 4. Allan Waters, “Active filter design”, New York, McGraw-Hill, 1991. 5. Passive and Active Filters (Theory and Implementations) By: Wai-Kai Chen

COURSE ARTICULATION MATRIX

Mapping of Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#3	3	3	3	1	1	1	1	1	1	1	1	1	3	3	2
CO#4	1	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	2	3	1	2	1	2	2	1	1	1	1	1	2	3	2
CO#6	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE616	VLSI Technology	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
BasicElectronics (ECC01), PhysicsofSemiconductor Devices (PHC331)		CT+MT+EA					
Course Outcomes	CO#1: Outline basic knowledge of semiconductor materials, devices and growth process of Si devices CO#2: Identify the process flow of device fabrication. CO#3: Illustrate the each process method of VLSI technology CO#4: Build the knowledge of integrated process technology						
Topics Covered	**Module1: Introduction**[3L] Materials,Definitions,Scalinglaws,IdeaofCleanroom,SiSubstrate Growth and Cleaning of Si **Module2: Oxidation** [5L] Oxidation:ProcessofOxidation,TypesofOxidation,Deal-GroveModel,Dependenceof oxidationondifferentparameters,ApplicationsinICtechnology,LOCOS. **Module3: Lithography**[6L] Processflowoflithography,ComponentsofLithography,Aligner; Contact,Proximity,Projection,MetricsofLithography,Photoresist-PositiveandNegative, Mask,Nextgenerationlithography. **Module4: Diffusion and Ion Implantation** [7L] BasicConcepts,DiffusioninSi,PolySi,BasicProcess:Pre-deposition andDrive-inDiffusion,ProblemsinThermalDiffusion,AdvantagesofIonImplantation, IonImplantationsystem,Mechanism,ImplantationProfile,JunctionDepth, DoseandConcentration relationship,IonImplantationdamageandannealing,Ion Channeling,MultiImplantation.						

	Module5: ThinFilmDeposition[6L] RequirementsofdepositionMethods:PhysicalVaporDepositionandChemicalVapordeposition,StepCoverageandFillingIssues. **Module6Etching:**[3L] Etchprocess,Requirements,Figureofmerits,TypesofEtch,DryandPlasmaEtch,IonenhancedEtch. **Module7: Metallization and Interconnect**[6L] Interconnect,Interconnectrequirements,PossibleInterconnectmaterials,Al metallization,Alspikeproblem,HillocksandVoids,ElectromigrationProblems,Methods toreducetheproblems,MetalsilicidesMultilevelMetallization,Wplugsforcontactand vias,IntermetalDilectrics. **Module8: ICprocessIntegration**[6L] SimpleResistor,Capacitor,NMOS.
Text Books, and/or reference material	1.VLSITechnology: SMSze 2.SiliconProcessTechnology: SKGandhi 3.SiliconVLSITechnology:Plummer,DealandGriffin 4.FundamentalofSemiconductorFabrication:SzeandMay

COURSE ARTICULATION MATRIX

Mapping CO (Course outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO / CO	PO# 1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO# 2	PSO# 3
CO#1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO#2	1	2	1	1	1	1	1	1	1	2	1	1	2	2	1
CO#3	2	3	2	2	3	1	2	1	1	2	1	2	3	3	2
CO#4	3	1	3	3	2	1	1	1	2	2	2	3	3	3	3

Correlation levels 1, 2 or 3 as defined below:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE617	Probability and Random Signal Theory	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT),End Assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	• CO1: Characterize probability models and function of random variables. • CO2: Evaluate and apply moments, ACF, PSD & characteristic functions and understand the concept of inequalities and probabilistic limits. • CO3: Recognize, interpret and apply a variety of deterministic and nondeterministic random processes that occur in engineering.						

Topics Covered	1. Introduction: Basic of Probability theory, Bernoulli's Trials (5L) 2. Random Variables: types, examples, PDF, PMF, Conditional probability density function, (10L). 3. Function of one random variable. (4L) 4. Mean, Variance, Moments, Characteristics functions of random variables (5L) 5. Two random variables, Joint density and distribution function, one function of two random variables, Two functions of two random variables (8L) 6. Random processes: definitions and notations, Autocorrelation function, Cross correlation function, Covariance, PSD, Markov Processes, Gaussian Process, Poisson Process, Systems and random signals (10L)
Text Books, and/or reference material	**Text Books**: 1. A. Popoulis, U. Pillai, *Probability, random variables and stochastic processes*, Tata McGraw-Hill Inc., 4th Ed., New Delhi, 2017 2. K. Sam Shanmugam, *Digital and analog communication systems*, Wiley, India, 2011. 3. P. Peebles, *Probability, random variables and random signal priniciples*, McGraw-Hill Inc., 4th Ed., New York, USA, 2001 4. C. W. Therrien, M. Tummala, *Probabilty and random processes for electrical and computer engineers*, 2nd Ed., CRC press, printed in India, 2012 **Reference Books**: 1. George R. Cooper, C. D. McGillem, *Probabilistic methods of signal analysis and system analysis*, Oxford University Press, 3rd Ed. , New Delhi, 2007 2. Alberto Leon-Garcia, *Probability and random processes for electrical engineering*, Pearson Education Inc., 2nd Ed., 2007

COURSE ARTICULATION MATRIX

Mapping the Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO# 1**	**PO# 2**	**PO# 3**	**PO# 4**	**PO# 5**	**PO# 6**	**PO# 7**	**PO# 8**	**PO# 9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO# 2**	**PSO #3**
CO#1	3	3	2	2	1	1	1	-	1	1	2	3	3	1	2
CO#2	3	2	2	2	2	-	-	-	-	1	1	1	3	2	2
CO#3	3	2	2	3	2	-	-	-	-	-	-	1	3	2	1

Correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 44				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE618	Data Communication and Computer Networks	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and End Assessment (EA))					
Analog Communication (ECC401), Digital Communication (ECC501)		The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.					
Course Outcomes	CO1: **Understand** the rudiments of how computers communicate CO2: **Acquaintance** with the architecture of a number of different networks CO3: **Understand** the principles of protocol layering CO4: **Understand** the basic aspects of packet based protocol design and implementation						

	CO5: **Analyze** and **Explain** the information flow in network traffic CO6: **Interpret** the importance of interconnection networks
Topics Covered	**Course Introduction and Physical Layer – [4L]** Data communication; Networks; Protocols and standards; Layered tasks; OSI Model; TCP/IP protocol suite; Addressing; Physical layer and media; Data and Signals; Analog and Digital; Transmission impairment; Line coding; Block coding; Sampling; Modulation of digital data; Telephone modems; Modulation of Analog signals; FDM,WDM,TDM, Guided media; Unguided media; Circuit switching; Telephone networks; DSL technology; Cable modem; SONET. **Data Link Layer, Framing, and Error Handling– [8L]** Types of errors; Error detection; Error correction; Flow and error control; Stop and wait ARQ, go back N ARQ, Selective Repeat ARQ; HDLC; Point to Point protocol; random access; Controlled access; Traditional Ethernet; Fast Ethernet; Gigabit Ethernet; IEEE802.11; Bluetooth; Backbone network; Virtual LAN; Cellular Telephony; Satellite Networks; Virtual Circuit switching; Frame relay; ATM. **Queuing Analysis in Communication Networks– [10L]** Introduction to queuing models; Little's theorem; M/M/1,M/M/m queues; Networks of queues; M/G/1 queues; M/G/1 queues with occupancy distribution; M/G/1 queues with vacations, reservations, Priority queues; Stability of queuing systems; Multiple access and ALOHA; Stabilized ALOHA; Tree algorithms; CSMA, CSMA/CD and Ethernet **Network Layer Concepts – [5L]** Internetworks; Addressing; Routing; ARP; IP; ICMP; IPV6. **Transport Layer Concepts– [5L]** Process to process delivery; User Datagram Protocol (UDP); Transmission Control Protocol (TCP); Data traffic; Congestion control; Quality of Service(QoS); Integrated services; Differentiated services; QoS in switched networks **Routing and Flow Control– [8L]** High speed LANs; Token rings; Introduction to Switch Architecture; High speed switch scheduling; Broadcast routing and spanning trees; Shortest path routing; Distributed routing algorithms; Optimal routing; Flow control window/credit schemes; Flow control rate based schemes; ATM networks. **Application Layer, WWW and HTTP – [4L]** Domain Name System, Dynamic Domain Name System; Encapsulation; Remote Logging; Electronic mail and File transfer; HTTP architecture; Simple Network Management Protocol (SNMP); Multimedia; Digitizing Audio and Video; Audio and Video compression; Streaming stored Audio/Video; Streaming live Audio/Video; Real time interactive Audio/Video; RTP; RTCP; Voice over IP.
Text Books, and/or reference material	**Text Books**: 1. Ferouzan, Behrouz A., "Data Communications and Networking", TMH. 2. William Stallings, "Data and Computer Communication", Pearson Education. 3. Bertsekas, Dimitri, and Robert Gallager, "Data Networks", Upper Saddle River, NJ: Prentice Hall **Reference Books**: 1. Tanenbaum , A.S., "Computer Networks", Upper Saddle River, NJ: Prentice Hall 2. Black, Ulylers D., "Data Communication and Distributed Networks", PHI.

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	1	1	2	1	2	2	1	2	1	2	2	2	2	1

CO#2	2	2	2	2	1	1	1	1	1	1	2	3	2	2	2
CO#3	2	2	2	2	1	1	1	1	1	1	2	3	1	2	2
CO#4	2	2	2	2	1	1	1	1	1	1	2	3	1	2	2
CO#5	3	3	3	3	2	2	2	1	1	1	1	2	2	3	3
CO#6	3	3	3	3	2	2	2	1	1	1	1	2	2	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE619</td><td>Mobile Computing</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3">Data Communication and Computer Networks (ECE618)</td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Introduce to the basic of Wireless Networks.
● CO2: Preparing the right background to take up research works in emerging wireless technologies and Internet of Things.
● CO3: To introduce the scopes of using sensing, edge computing, Machine learning mechanisms in pervasive cyber physical systems.
● CO4: Able to understand the innovation opportunity in IoT application segments.
● CO5: Hands-on experience on Wireless Networks & Mobile Computing.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module 1: Physical Layer (6 Hours)
Bit transmission over Wireless, Vary Much different from Wired Network.
Module 2: Mac Layer (8 Hours)
Access in Shared Medium, Difference between Wired MAC & Wireless MAC, Different Type of MACs (a) Random MAC (b) Scheduled MAC, Examples of MAC Implementation (WiFi Protocol --802.11, Bluetooth Protocol--805.15).
Module 3: Network Layer (8 Hours)
Reactive Routing, Proactive Routing, DSR Principle, AODV Principle, Location Aware Routing. Adhoc Network, Delay Tolerant Network, Opportunistic Network Introduction, Architecture & Applications, Routing Algorithms – Epidemic, Prophet, Spray & Wait, Spray & Focus, Maxprop Simulation Tool - ONE Simulator.
Module 4: Transport Layer (8 Hours)
Wireless TCP and rationale, Difference between Wired TCP and Wireless TCP, QoS Measurement of Wireless Networks.
Module 5: Modelling (8 Hours)
Mathematical Modelling of Network Functionalities - Combining them to derived overall performance.
Module 6: Case Study: Implementation of opportunistic Networks in Challenged Network scenarios (4 hours)
(a) Connection Mechanism (b) Sync - Transferring the information in Collaborative manner (c) Offline Dashboard (Information Summarization) (d)security</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. “Mobile Communication”, by Jochen Schiller (PEARSON EDUCATION LIMITED).
2. “Wireless Networking” A kumar, D. manjunath, J. Kuri, Elsevier, 2008.
3. “Wireless Communication”, T. S. Rappaport, Pearson, latest edition.</td></tr>
</table>

	Research Papers: 1. IEEE Infocom Tutorials slides by Prof. NitinVaidya. **Others:** Tools: ● Sniffer Tool (Wireshark) ● Simulation Tools: OMNET ONE NS3

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	3	3	2	1	1	1	1	1	-	2	-	2	2	2	3
CO#2	3	2	2	2	2	1	1	-	-	1	1	2	3	2	3
CO#3	3	2	3	3	3	2	2	1	-	3	3	2	3	3	3
CO#4	3	3	2	1	1	1	1	1	-	2	-	2	2	2	3
CO#5	3	2	2	2	2	1	1	-	-	1	1	2	3	2	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE620	Nanoelectronics	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
Electronic Devices and Circuits (ECC302), Physics of Semiconductor Devices (PHC331)		CT+MT+EA					
Course Outcomes	● CO1: Understand state of the art in semiconductor device physics and materials technology to enable the Nano-Electronics. ● CO2: Apply the fundamentals of classical CMOS technology. ● CO3: Implement the scaling of MOSFET in the sub-100nm regime. ● CO4: Apprehend the need of non-classical transistors with new device structure and Nano-materials.						
Topics Covered	**Module I: (L – 4)** Introduction to nanotechnology, the size of things, history of nanotechnology, fabrication method (top-down and bottoms-up), emerging applications of nanotechnology **Module II: (L – 8)** Electronic and Optical properties of nanostructures. Energy sub-bands. Electron						

	transport in two –dimensional electron gas (density of states), Carrier scattering, resistance of a ballistic conductor, Transmission probability calculation, Electron tunneling, Resonant tunneling, Coupled nanoscale structures and Super lattices. **Module III: (L – 10)** Shrink-down approaches: Electronic devices Based on Nanostructures: Advance Heterostructure Devices, Downscaling of the MOSFET. Nanoscale FET Transistors, the Ballistic FET, Resonant Tunneling Devices and Circuits, Single Electron Transistor and Related Devices. Devices based on carbon nanotubes, Spintronic Devices. **Module IV: (L – 10)** Optoelectronic Devices using Nanostructures: Quantum well and Quantum Dot LASERS, Quantum Cascade LASER, Quantum well infrared photo detector, Super lattice LASER. **Module V: (L – 10)** Nanotechnology: Deposition techniques for Nanoscale Devices, Nanolithography, Self-Assembly Techniques, Nanomaterials, Nanoparticles, Nanowires, Nanomagnetic Materials, Nanostructure Surfaces; Instrumentation for nanoscale electronics: The Atomic Force Microscope (AFM), Scanning Tunneling Microscope and scanning near field optical microscope.
Text Books, and/or reference material	1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens,Wiley (2003). 2. Nanoelectronics and Information Technology (Advanced Electronic Materials and Novel Devices), WaserRanier,Wiley-VCH (2003). 3. Nanosystems, K.E. Drexler, Wiley (1992) 4. The Physics of Low-Dimensional Semiconductors, John H. Davies, Cambridge University Press, 1998. 5. Fundamentals of Modern VLSI Devices, Y. Taur and T. Ning, Cambridge University Press. 6. "Nanoelectronics and Nanosystems," Karl Goser, Springer, 2004

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO#2	2	2	3	2	3	-	1	-	-	-	-	2	2	3	2
CO#3	2	2	3	2	1	-	-	-	-	-	-	2	3	2	2
CO#4	2	3	2	3	3	2	1	1	-	-	-	2	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE621	Measurement and Instrumentation	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
None		CT+MT+EA					
Course Outcomes	CO#1: Understand characteristics of general measurement system CO#2: Apply qualitative analysis techniques in general measurement system CO#3: Apply quantitative analysis techniques in general measurement system CO#4: Understand basic building blocks of general measurement system CO#5: Design general measurement systems with functional blocks CO#6: Investigate complex designs in measurement systems with functional blocks						
Topics Covered	1. General measurement system, Static and dynamic characteristics of measurement systems [8L] 2. Loading effect, two port network model of measurement systems, signal noise [6L], 3. Reliability, Choice and Economics of Measurement Systems [3L] 4. Lagrangian dynamics [4L] 5. Sensing elements [6L] 6. Signal conditioning and Processing, Data presentation [6L] 7. Case studies in measurement system: [9L]						
Text Books, and/or reference material	**Text Books**: 1. Principles of Measurement Systems, John Bentley, 3rd Edition. **Reference Books**: 1. Mechatronics, A. Preumont. 2. Electronic Instrumentation and Measurements, David A. Bell, 3rd Edition.						

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#2	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#3	2	3	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#4	1	1	3	2	1	1	1	1	1	1	1	1	2	3	1
CO#5	1	1	3	2	1	1	1	1	1	1	1	1	2	3	1
CO#6	1	1	2	3	1	1	1	1	1	1	1	1	2	3	1

Correlation levels 1, 2 or 3 as defined below:
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE622</td><td>Digital IC Design</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods: (Continuous (CT), Mid-semester assessment (MA) and end assessment (EA)):</td></tr>
<tr><td colspan="2">Digital Circuits and Systems (ECC402)</td><td colspan="6">Assignments, Mid-semester Examination and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of the course, a student will be able to:
CO#1: Understand the characteristics of CMOS inverter and interconnects.
CO#2: Study the Static and dynamic characteristics of MOS inverter
CO#3: Learn the basic steps of ASIC and fabrication process.
CO#4: Analyze the performance of CMOS inverter circuits.
CO#5: Illustrate the combinational and sequential logic circuits
CO#6: Understand the recent trends in VLSI Design & its research issues in industry/ academia</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module-I: (L – 3)
Overview of VLSI Design: Historical perspective, overview of VLSI design methodologies, VLSI design flow, design hierarchy, concepts of regularity, modularity, and locality, VLSI design styles, design quality, packaging technology, CAD technology, ASIC Design flow.
Module-II: (L – 6)
Fabrication of MOSFETs:Fabrication process flow- basic steps, the CMOS n-Well process, layout design rules, stick diagram, full-custom mask layout design.
Module-III: (L – 6)
MOS Transistor: The metal oxide semiconductor (MOS) structure, MOS system under external bias, structure and operation of MOS transistor (MOSFET), MOSFET current-voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances.
Module-IV: (L – 4)
Modelling of MOS Transistors: Basic concepts, state-of-art MOSFET models, capacitance models, comparison of SPICE MOSFET models.
Module-V: (L – 4)
MOS Inverter (Static Characteristics): Resistive-load inverter, inverter with n-type MOSFET load, CMOS inverter.
Module-VI: (L – 4)
MOS Inverters (Switching Characteristics and Interconnects effects): Delay-time definitions, calculation of delay times, logical efforts, inverter design with delay constraints, estimation of interconnect parasitics, calculation of interconnect delay, Bus vs. Network-on-Chip (NoC), switching power dissipation of CMOS inverters.
Module-VII: (L – 5)
Combination CMOS Logic Circuits: MOS logic circuits with depletion nMOS loads, CMOS logic circuits, complex logic circuits. CMOS transmission gates (pass gates).
Module-VIII: (L – 5)
Sequential MOS logic circuits:Behavior of bistable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch and edge-triggered flip-flop.
Module-IX: (L – 5)
Dynamic logic Circuits: basic principle of pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, dynamic CMOS circuit techniques, high-performance dynamic CMOS circuits.</td></tr>
</table>

Text Books, and/or reference material	**Text Book**: 1. CMOS Digital Integrated Circuits, Sung-Mo Kang,YusufLeblebici, 3rd edition, Tata McGraw-Hill, 2003 **Reference Books**: 1. J. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd Edition, Prentice Hall 2004. 2. N. H. E. Weste and C. Harris, "Principles of CMOS VLSI Design: A System Perspective, 3rd Edition, Pearson Education 2007.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO #3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#3	3	3	3	1	1	1	1	1	1	1	1	1	3	3	2
CO#4	1	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	2	3	1	2	1	2	2	1	1	1	1	1	2	3	2
CO#6	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE623	Mechatronics Systems	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT),End Assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	● CO1: **Understand** characteristics of mechatronics system ● CO2: **Apply qualitative analysis** techniques in mechatronics system ● CO3: **Apply quantitative analysis** techniques in mechatronics system ● CO4: **Understand** basic building blocks of general mechatronics system ● CO5: **Design** general mechatronics system with functional blocks ● CO6: **Investigate complex designs** in mechatronics system and case studies						
Topics Covered	Introduction to mechatronics [1L] Sensors and Transducers, Pneumatic and Hydraulic, Mechanical Actuation Systems, Electrical actuation systems [8L] Signal Conditioning circuits [4L] Digital Processing Elements [3L] Data Presentation Systems [2L] System models and Dynamic response [3L] System Transfer functions and frequency response [3L]						

	Closed loop controllers [2L] Artificial Intelligence [2L] Microcontrollers and programming [4L] Interfacing and communication [2L] Case studies [8L]
Text Books, and/or reference material	**Text Book**: 1. Mechatronics, by W. Bolton, Fourth Edition, Pearson

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#2	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#3	2	3	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#4	1	1	3	2	1	1	1	1	1	1	1	1	2	3	1
CO#5	1	1	3	2	1	1	1	1	1	1	1	1	2	3	1
CO#6	1	1	2	3	1	1	1	1	1	1	1	1	1	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE624	Power Electronics	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous Assessment (CA), Mid-semester assessment (MA) and end assessment (EA))					
Basic Electronics (ECC01), Signals and Systems (ECC303)		Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination					
Course Outcomes		● CO1: To learn the details of power semiconductor switches (Construction, Characteristics and operation) and working of various types of converters. ● CO2: To learn how to analyse the converters and design the components of them, under various load types. ● CO3: To learn about the control of various converters. Recognize the role power electronics play in the improvement of energy usage efficiency and the applications of power electronics in emerging areas.					

Topics Covered	**Module-1 (**duration- 4 hrs) Introduction: Application of Power Electronics to : 1) Motor control with emphasis on Traction and Industrial Process control 2) Power Supplies - Revolution in Personal Computers UPS 3) Power Transmission - Facts Technology, HVDC 4) Chemical Process 5) Battery charging 6) Power extraction from non-conventional enery sources 7) Automotive electronics 8) High energy physics Evolution of Power Electronics Days of Mercury arc rectification--forerunner of Power Electronics Invention of SCR and its impact Advent of Self-commutated switches and their impact **Module-2 (**duration-4hrs) Structure of Power Electronics: How structurally power electronics differs from low power analog electronics Different types of switches Power Diodes: from the viewpoint of an application engineer SCR: Device structure, Static characteristic, dynamic characteristic constraints of Turn on and Turn off time, different relevant ratings. **Module-3 (**duration-4hrs) Diode rectifiers Applications: Power Supplies, Front end converter for ac motor drives, battery charger, chemical process 1) Single phase Half wave with R load 2) Single phase Half wave with R-L load 3) Single phase Full bridge rectifier with dc link capacitive filter, issue of harmonics 4) Three phase Full bridge rectifier with dc link capacitive filter, issue of harmonics **Module-4 (**duration-5hrs) AC to DC controlled converters Application: DC Motor Drives Battery chargers HVDC transmission 1) Single phase fully controlled AC to DC converter i) Principle of operation: Issue of line commutation ii) Continuous mode of conduction: expression for average output voltage iii) Modes of operation in the voltage-current plane iv) discontinuous mode of conduction v) analysis with R-L-E load, significance of R-L-E load vi) operation as an inverter: constraints for line commutation vii) Dual converter: motivation Simultaneous and nonsimultaneous control vii) input displacement factor, distortion factor, harmonics viii) Effect of source inductance ix) Requirement of snubber 2) Single phase half controlled converter: operating principle, input displacement factor Modes of operation in the voltage-current plane Modes of operation in the voltage-current plane **Module-5 (**duration-2 hrs) Three phase half wave ac to dc converter Principle of operation Derivation of o/p voltage issue of dc magnetization of the input transformer **Module-6 (**duration-3 hrs) Three phase fully controlled ac to dc converter

	Principle of operation Derivation of average output voltage Derivation of displacement factor Inverter mode of operation Constraints of commutation in inverter mode Effect of source inductance **Moduel - 7 (**duration-4 hrs) Limitation of Line commutated converters Single phase unity powerfactor converter Principle of switched Power power conversion Bi-directional Power converters **Module- 8 (**duration-8 hrs) DC- DC Power Converters Limitations of Linear Power supplies Switched Power Power supplies (Buck, Buck-Boost, Boost, Cuk, Fly-back and Forward Convverters) Transfer fucntion for these converters **Module-9 (**duration-8 hrs) Motivation DC- AC Power Converters Principle of operation of Inverters Half bridge, full bridge, three phase- six step operation, voltage control, PWM techniques
Text Books, and/or reference material	**Text Books:** 1. M.H.Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, PHI Third Edition, New Delhi, 2004. 2. P.S.Bimbra "Power Electronics" Khanna Publishers, third Edition, 2003. 3. L. Umanand, " Power Electronics Essentials and Applications", Wiley, 2010. **Reference Books:** 1. Joseph Vithayathil, 'Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013. 2. Ashfaq Ahmed Power Electronics for Technology Pearson Education, Indian reprint, 2003. 3. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2004 Edition. 4. Ned Mohan, Tore. M. Undel and, William. P. Robbins,' Power Electronics: Converters, Applications and Design', John Wiley and sons, third edition,2003. 5. Daniel.W.Hart, "Power Electronics", Indian Edition, McGraw Hill, 3rd Print.

COURSE ARTICULATION MATRIX

Mapping of Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome(PSO)															
PO / PSO CO	**PO# 1**	**PO# 2**	**PO# 3**	**PO# 4**	**PO# 5**	**PO# 6**	**PO# 7**	**PO# 8**	**PO# 9**	**PO# 10**	**PO# 11**	**PO# 12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	2	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	3	1	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE625</td><td>Optical Communication</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-semester assessment (MA) and end assessment (EA)):</td></tr>
<tr><td colspan="3">Electromagnetic Theory and Transmission Lines (ECC403),
Analog Communication (ECC401),
Digital Communication (ECC501)</td><td colspan="5">Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO#1 Students will be able to understand circuits and system level implementation in lightwave technology.
CO#2 The students can design components and choose appropriate sources and receivers for an optical network.
CO#3 Understanding the usage of OTDR in monitoring an optical communication system.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="7">Introduction to fiber optics, principles of optical fiber; Advantages. Elements of an optical fiber transmission link. [4L]
Optical fiber characteristics, types of optical fibers; Attenuation and Dispersion in optical fiber: Signal attenuation and distortion in optical fibers, Dispersion effects in optical fibers.; OTDR [10L]
Optical Sources: Structure and materials of LED and LD sources operating characteristics and modulation capabilities of the LED and LD sources. Source to Fiber Power launching and coupling, Lensing schemes for coupling improvement, Fiber to fiber couplings and alignment methods, Splicing techniques, Fiber Connectors. [8L]
Optical Receiver: Optical receiver configuration and performance, Pre-amplifier design for optical receiver, analog and Digital receiver. Point to point transmission links, Wavelength division multiplexing, Optical data buses, Link power and rise time budget, Optical Amplifier. [8L]
Optical Networking: Fiber optics in LAN, MAN, SAN, WAN, FDDI architecture, SONET/ SDH architecture, SONET/ SDH network elements [8L]
Potential applications and future prospects of optical fibers, multimode intensity sensors and single mode, Interferometric sensors; Free space optical communication [4L]</td></tr>
<tr><td>Text Books, and/or Reference material</td><td colspan="7">Text Books:
[1] J. M. Senior, “Optical Fiber Communications”, PHI, 2nd Ed.
[2] G. Keiser, “Optical Fiber Communication”, McGraw Hill, 3rd Ed.
[3] Ghatak &Thyagarajan, “Introduction to fiber Optics”, Cambridge University press.
[4] Henry Zanger and Cynthia Zanger, Fiber Optics Communication and Other Application, Macmillan Publishing Company, Singapore 1991.
Reference Books:
[1] J.H.Franz&V.K.Jain, “Optical Communications”, Narosa Publishing House.
[2] Ghatak &Thyagarajan, “Contemporary Optics”, Series Title: Optical Physics and Engineering, Springer
[3] AmnonYariv and PochiYeh, Photonics: Optical electronics for Modern Communication, 6th Ed., New York, Oxford University Press</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO / PSO CO	**PO# 1**	**PO# 2**	**PO# 3**	**PO# 4**	**PO# 5**	**PO# 6**	**PO# 7**	**PO# 8**	**PO# 9**	**PO# 10**	**PO# 11**	**PO# 12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	2	2	2	3	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEVENTH SEMESTER

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 43				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MSC731	Principles of Management	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	• CO1:To make budding engineers aware of various management functions required for any organization • CO2:To impart knowledge on various tools and techniques applied by the executives of an organization • CO3:To make potential engineers aware of managerial function so that it would help for their professional career • CO4:To impart knowledge on org. activities operational & strategic both in nature • C05: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science, Quantitative Techniques and Decision Science						
Topics Covered	**UNIT I:** Management Functions and Business Environment: Business environment- macro, Business environment -micro; Porter's five forces, Management functions –overview, Different levels and roles of management, Planning- Steps, Planning and environmental analysis with SWOT, Application of BCG matrix in organization **(8L)** **UNIT II:** Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis, PERT & CPM as controlling technique **(7L)** **UNIT III:** Creating and delivering superior customer value: Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting & Positioning, Product Life cycle. **(8L)** **UNIT IV:** Behavioral management of individual: Motivation, Leadership, Perception, Learning. **(8L)** **UNIT V:** Finance and Accounting: Basics of Financial management of an organization, Preparation of Final Accounts, Analysis of Financial statements, Cost Volume Profit (CVP) Analysis, An overview of financial market with special reference to India. **(12L)**						
Text Books, and/or reference material	**Text Books**: 1. Financial Management, 11th Edition, I M Pandey, Vikas Publishing House. 2. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India 3. Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education 4. Organizational Behavior,13 th edition, Stephen P Robbins, Pearson Prentice hall India 5. Operations Management, 7th ed.(Quality control, Forecasting), Buffa&Sarin, Willey						

COURSE ARTICULATION MATRIX

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	-	-	-	-	-	-	-	-	3	2	2	-	2	1	1
CO#2	-	-	-	2	-	-	-	-	2	2	-	-	2	1	1
CO#3	-	-	-	2	-	-	-	-	3	2	-	-	2	1	1
CO#4	-	-	-	-	-	-	1	-	3	-	-	-	2	1	1
CO#5	-	-	-	2	-	-	-	-	2	2	2	-	2	1	1

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 30</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS751</td><td>Computer Aided Design Lab</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">VLSI Design Lab (ECS652)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Employ CAD tools to carry out Analog IC Design using bottom up approach
● CO2: Illustrate NMOS and PMOS transistor and its use in Analog Circuit Design
● CO3: Design common source amplifier to meet any given specification.
● CO4: Design and implementation of various components of a processor.
● CO5: Evaluate the performance of VLSI Designs.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">List of experiments:
1. Plot the NMOS I/V characteristics and measure its VT, $\mu_N C_{OX}$, g_m, f_T at the DC bias point of $V_{DS} = 0.5\ V$, and $V_{GS} = 0.4\ V$. Also determine the corresponding values for PMOS transistor at $V_{DS} = 0.6\ V$, $V_{GS} = 0.5\ V$
2. For an NMOS with W/L = 500n/500n, plot g_m, $\frac{g_m}{I_D}$, V_T, f_T, r_{out} and self-gain by sweeping $0 < V_{GS} < 1V$ for $V_{DS} = 0.3\ V, 0.5\ V and\ 0.9\ V$. Interpret the results.
3. Simulate the VTC of pseudo-NMOS inverter so that $V_M = 0.5\ V_{DD}$. Now measure the Noise margins and t_{PLH}, t_{PHL} when CL = 1 pF. Also, measure the static power and dynamic power dissipation when the clock frequency is 10 MHz.
4. Design a CMOS Common Source Amplifier with PMOS active load from a min. gain of 20 dB. Plot its frequency response when a load of 1 pF is connected. Measure its power dissipation (PD).
5. Design and implementation of ALU and ALU Controller for MIPS processor.
6. Design and implementation of Sequence Controller for MIPS processor.
7. Design and implementation of Multiplexer and Program Counter for MIPS processor.
8. Design and implementation of Concentration, Combinational and shift-by-2 modules for MIPS processor.
9. Design and implementation of RAM and Register files for MIPS processor.
10. Design and implementation of State Register and Sign-Extend Modules for MIPS processor.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">1. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill Education, 2002.
2. Allan Hastings, “The Art of Analog Layout”, Prentice Hall, Second Edition, 2005.
3. N. H. E. Weste and C. Harris, “Principles of CMOS VLSI Design: A System Perspective”, 3rd Edition, Pearson Education 2007.</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	2	1	1	1	1	1	1	1	1	1	2	2	2
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	2	2
CO#3	3	3	3	1	2	2	1	1	1	1	1	1	3	3	2
CO#4	1	2	1	1	1	1	1	1	1	1	1	1	2	2	2
CO#5	2	3	1	2	2	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 40</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS752</td><td>Electronic System Design Lab</td><td>PCR</td><td>0</td><td>0</td><td>4</td><td>4</td><td>2</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Electronic Devices andCircuits I, II (ECC302, ECC504), Electrical Technology (EEC01)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Understand experimental design procedure
• CO2: Develop troubleshooting techniques
• CO3: Design electronic systems focusing on application
• CO4: Develop skill to use modern engineering software tools
• CO5: Develop technical report writing skill
• CO6: Develop team activity for executing projects</td></tr>
<tr><td>Topics Covered</td><td colspan="7">• Introduction to electronic system design
1. Induction class on System Design, Fabrication and Troubleshooting
• Power supply design
2. Application of different types of batteries
3. Regulated DC power supply design
• Experiments with Sensors and Actuators
4. LDR, Phototransistor, Piezoelectric elements, Hall sensor, inductive pickup
5. DC motor and BLDC motor driving, solenoid actuator. Speed control of motor using PWM, Servo motor, SMA actuator
• Design of signal conditioning circuits
6. Electronic signal amplifier, Instrumentation amplifier design
7. Low pass, High pass, Band pass, Band stop Filter design
• Design of signal processing systems
8. Introduction to microcontrollers 8052/Arduino/Raspberry pi
9. Data acquisition via microcontrollers and interfacing with Matlab
• Integration of data presentation elements
10. Interfacing display unit with microcontrollers
11. Data presentation using GUI</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS
1. Principles of Measurement Systems, John Bentley, Pearson
2. Electronic Circuits: Analysis and Design by Donald A Neamen
3. Mechatronics, by W. Bolton, Fourth Edition, Pearson
4. Digital Fundamentals by Floyd
5. Laboratory Experiments manual</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	2	1	1	1	-	-	-	1	1	1	1	3	2	1
CO#2	3	2	1	1	1	-	-	-	1	1	1	1	3	2	1

CO#3	1	2	3	1	1	-	-	-	1	1	1	1	1	3	2
CO#4	1	2	1	1	3	-	-	-	1	1	1	1	3	2	1
CO#5	1	1	1	1	1	1	1	2	1	3	1	1	3	2	1
CO#6	1	1	1	1	1	1	1	1	2	1	2	1	3	2	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 18				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS753	Advanced Communication Lab	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	On successful completion of this course, students should have the skills and knowledge to: CO#1. Understand Monte Carlo Simulation of Discrete and Continuous random variables CO#2. Estimate Bit Error Rate (BER) of a Communication Systems CO#3. Evaluate the performance of simple modulation over AWGN and Fading Channel (typically Rayleigh and other) CO#4. Model fading channels and understand Digital Communication concepts in context to fading channels. CO#5. Assess the performance of simple Network Access protocols like ALOHA and S-ALOHA by simulation. CO#6. Develop expertise in writing program using MATLAB and tools like SIMULINK.
Topics Covered/ Syllabus	1. Discrete Event Simulation : 1. (A) Generation of random variables. (a) Discrete (i) Poisson (ii) Binomial (iii) Geometric (b) Continuous (i) Gaussian (ii) Exponential (iii) Lognormal (iv) Rayleigh (v) Erlang (vii) Generate Gaussian from uniform distributed Random variable. Generate the r.v-s with suitable chosen parameters. 1. (B) Generate the PDF (probability density function) of the r.v-s by simulation. Match the simulated pdf with the corresponding analytical pdf-s. [show this for (b)i , b(iii) and b(iv) cases]. 2. (A) Simulation of AWGN channel and BER performance of BPSK. (Generate BPSK at baseband, Tx through a channel corrupted by Gaussian noise of a given noise var. Rx the signal bit, compare it with Tx bit and estimate BER via no. of iteration). Plot the BER vsEb/No. (B) Simulate Packet error rate (PER) in above for an arbitrary packet of size L = 500 bits. 3. Repeat the above Expt no.2 (a) for a Rayleigh faded channel. 4. Generate a PN sequence of (a) 15 bits (b) 31 bits. Simulate and plot the autocorrelation function of generated PN sequence. 5. Simulate the arrival process in a Poisson based arrival with typical mean arrival rate (for example 0.84 calls/sec.) Using above simulate Throughput for ALOHA and S-ALOHA protocol(s). 6. Simulation and Performance studies of QPSK and Offset QPSK (using MATLAB

	and SIMULINK)
Text Books, and/or Reference material	1. Simulation Modeling and Analysis : Law and Kelton McGraw-Hill 2. Simulation : Sheldon Ross, Academic Press 3. Contemporary Communication Systems : M.F. Mesiya McGraw-Hill India 4. Modern Communication Systems using MATLAB, John Proakis, MasudSalehi and Gerhard Bauch, Third Ediation, CENGAGE Learning

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	2	3	2	-	-	-	1	1	-	1	3	2	2
CO#2	3	3	3	2	-	-	-	-	-	1	-	1	3	2	2
CO#3	3	3	3	2	-	-	-	-	-	1	-	1	3	2	2
CO#4	3	3	1	2	1	-	-	-	1	1	-	2	3	2	2
CO#5	3	3	2	3	2	1	-	-	1	1	-	1	3	2	2
CO#6	3	2	2	2	3	-	-	-	2	1	-	2	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 43				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE710	Detection and Estimation Theory	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
Probability Theory for Engineering Application (ECO541) / any equivalent content from NPTEL, SWAYAM etc.		CT+MT+EA					
Course Outcomes	• CO1: To familiarize students with Classical Statistical Inference Techniques and their applications to Communication and Signal processing • CO2: To familiarize students with Signal Detection Theory • CO3: To develop required mathematical skills for design and implementation of statistical signal processing algorithm						
Topics Covered	**Topic 1:Random Signal and Random Process Basics [5]** Important probability distribution functions: Gaussian, Chi-square, Rayleigh, Rician, Student's t, F, Cauchy etc. Bivariate and Multivariate Distribution Random Process, Correlation properties, Stationarity, Ergodicity, Gaussian Process, Power Spectral Density **Topic 2: Classical Decision Theory [10]** Introduction to signal detection problems						

	Bayes Criterion: Binary Hypothesis testing, M-ary hypothesis testing Maximum Likelihood based Optimal detection, LRT (Likelihood Ratio Test) and performance. Neyman Pearson Criterion for optimal detection , Minimum probability of error detector, Minimax Criterion **Topic 3:Detection of Deterministic and random Signal[8]** Matched Filter Detection, Optimal detection for white and Nonwhite noise, Multiple Hypothesis testing, Estimator Correlator, Energy Detector **Topic 5: Detection of Signal with unknown parameters [6]** Composite Hypothesis Testing : Bayesian Approach and GLRT, Sinusoidal detection **Topic 6**: **Estimation Techniques [8]** Introduction to signal Estimation, Unbiased estimators, Minimum variance unbiased estimator (MVUE), MVUE Criterion, Cramer Rao Lower bound(CRLB), Best Linear Unbiased Estimator(BLUE), General CRLB for signals in white noise, Least Square Estimation and Recursive Least Square Estimation. **Topic 7:Random parameter Estimation**: [**6**] Bayesian Formulation, Minimum mean square error (MMSE) and MAP estimation,Linear MMSE estimation, Wiener and optimum MMSE Filtering
Text Books, and/or reference material	**Text Books:** 1.Fundamentals of Statistical Signal Processing, (Vol 1 &Vol 2) S.M. Kay, Pearson 2. Detection, Estimation, and Modulation Theory, Part-1, VanTrees, Jhon Wiley **Reference Books:** 1. Signal Detection and Estimation, Second Edition,MouradBarkatArtechhouse. 2. An Introduction to Signal detection and Estimation: H. Vincent Poor, Springer-Verlag

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	2	1	1	1	1	1	1	1	3	2	2
CO#2	3	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO#3	3	3	3	2	1	1	2	1	1	1	1	1	3	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE711	Information Theory and Coding	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
NIL		CT+MT+EA					

Course Outcomes	**CO.1** Understand the concept of Information and quantitative from of characterization of information. **CO.2**Understand abstraction of digital information transfer and characterizestorage/transfer from mathematical viewpoint. **CO.3** Gain knowledge about techniques for information compression and its application **CO.4**Understand Channel Capacity and Shannon's Law on Information capacity. Appreciate information theoretic results as fundamental limits on performance ofCommunication systems. Analyze Capacity of Various Channels. **CO.5** Understand the fundamental difference between Source Coding theorem andChannel Coding theorem. **CO.6** Understand different approaches for error correction and suitability of theirApplication. Develop understanding of Block Coding.
Topics Covered	1.**Information Theory** : Introduction, Uncertainty and Information, Entropy, Relative Entropy, Mutual Information, Chain Rules, Differential Entropy , Properties of Differential entropy, Jensen's inequality, data processing Inequality. (9L) 2. **Source Coding**: Source Coding Theorem, Kraft Inequality, Optimal codes, Huffman Code, Shannon Fano Elias Coding, Lempel Ziv Coding, Rate Distortion function (8L) 3. **Channel Capacity and Coding** : Channel Models, Channel Capacity, Binary Symmetric Channel , Binary Erasure Channel, Channel Coding Theorem, Information Capacity Theorem, Shannon's limit, Gaussian Channel, Parallel Gaussian Channel. (10L) 4. **Error Control Coding**: Linear algebra fundamentals, Linear Block Codes, Generator matrix, Parity Check Matrix, Encoding and Decoding of linear Block Codes, Syndrome Decoding, Hamming Code, properties of linear Block Code, Cyclic Codes: Algebraic description, Encoding and Decoding of Cyclic codes , Convolution Codes: Definition, Encoding Trellis and State representation, , Viterbi decoding, Error probability, Viterbi Decoding. (15L)
Text Books, and/or reference material	1. Information Theory Coding and Cryptography, Third Edition, Ranjan Bose, McGraw-Hill Education Pvt. Limited. 2. Elements of Information Theory , Thomas M.Cover and Joy.A. Thomas, Wiley 3. Error Control Coding, Fundamentals and Application Shu Lin, Daniel J. Costello, Pearson, India 4. Error Correction Coding Mathematical Methods and application, Todd K. Moon, Wiley, India.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	2	1	2	1	1	1	1	1	1	3	2	1
CO#2	3	2	2	2	1	2	1	1	1	1	1	1	3	2	1
CO#3	3	3	3	2	1	2	1	1	1	1	1	1	3	3	2
CO#4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	3	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#6	3	3	2	3	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE712</td><td>Analog IC Design</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CA), Mid Term(MT) and End Term (ET))</td></tr>
<tr><td colspan="2">Electronic Devices and Circuits I and II (ECC302, ECC504)</td><td colspan="6">(CA+MT+ET=15+25+60=100)</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: Define various parameters/terms associated with MOS transistors and Analog IC design.
CO2: Describe the operation of a MOS transistor /Amplifier/other fundamental blocks.
CO3: Solve any given circuit using appropriate Large/Small Signal model equations.
CO4: Evaluate various performance metrics such as gain/BW/Power dissipation/Input & output range etc.
CO5: Analyze feedback circuit and determine its poles, zeros, gain margin & phase margin.
CO6: Design a Single stage Amplifier/Differential Amplifier to meet the given specifications.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module-I: Introduction to MOS (L – 04)
MOS Device Physics – General Considerations, Overview of CMOS technology, MOS I/V Characteristics, Short Channel Effects, Noise, Large Signal MOS Device models.

Module-2: Small Signal MOS Model(L – 02)
MOS Device Capacitance, Small Signal Device Models. Different trans-conductance (front gate : g_m, output: g_ds, back-gate:g_mb). Unity gain frequency calculation.

Module-3: Basic MOS Amplifiers(L – 08)
Single Stage Amplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage, Calculation of Amplifier parameters.

Module-4: Current Mirrors/References(L – 03)
Current Mirror: Simple, Cascode, Wilson, Wide-Swing.

Module-5: Frequency Response of Amplifiers(L – 06)
Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair.

Module-6: Differential Amplifier(L – 07)
Differential Amplifiers – Single Ended and double ended. Differential Operation, Basic Differential Pair, Common- Mode Response, Differential Pair with MOS loads, current mirror load.

Module-7: Single stage Opamps(L –07)
Operational Amplifiers – General Considerations, Single Stage Op Amps, Two Stage Op Amps, Input Range limitations(ICMR), Slew Rate, Noise and Offset in Op Amps.
Module-8: Feedback (L – 05)
Feedback-Types, Nyquist plot, Stability- Frequency compensation techniques, Miller compensation, pole splitting, Gain Margin, Phase Margin.</td></tr>
<tr><td>Text Books, and/or Reference</td><td colspan="7">Text Books:
[1] Design of Analog CMOS Integrated Circuits, by BehzadRazavi, McGraw-Hill, 2014.
[2] Adel Sedra, Kenneth C. Smith, Tony Chan Carusone, Vincent Gaudet, " Microelectronic Circuits", Oxford, 8th Ed. 2020</td></tr>
</table>

material	[3] Understanding Microelectronics: A Top-Down Approach by Franco Maloberti, Wiley (2011) **Reference Books**: [1]. Analysis and Design of Analog Integrated Circuit, Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, John Wiley & Sons, Inc., 5th edition 2015 [2]. CMOS: Circuit Design, Layout, and Simulation by R. Jacob Baker, Wiley-IEEE Press(2019)
Video Lectures	**NPTEL/SWAYAM Video Lectures:** https://www.youtube.com/watch?v=2i2PMtRDvE8&list=PLuv3GM6-gsE0ix0s_d6JNIQXePzXr3_GZ Prof. NagendraKrishnapura, IITM https://www.youtube.com/watch?v=pK2elUcXWzs&list=PLiDoPUX9nLkIw9EnIv_3K19wlcyJ6msYd [3]. Prof. BehzadRazavi, UCLA

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO# 3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	2	1
CO#3	3	3	3	1	1	1	1	1	1	1	1	1	3	3	2
CO#4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	2	3	1	1	1	2	2	1	1	1	1	1	2	3	1
CO#6	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE713	FPGA based Design	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous Assessment (CA: 15%), Mid-Term Assessment (MA:25%) and End-Term Assessment (EA:60%))					
Digital Circuits and Systems (ECC402), VLSI Design (ECC602)		Continuous Assessment (CA): Quizzes/Class tests/Assignments/Attendance					
Course Outcomes	●**CO1:** Learn logic synthesis techniques – two-level and multilevel synthesis. ●**CO2:** Be able to design systems using FPGAs and CPLDs. ●**CO3**: Learn sequential machine design using FPGAs. ●**CO4**: Learn to design systems for low power operation.						
Topics Covered	**Module-I:** (L – 04) Logic design fundamentals: Two level synthesis – SOP/POS forms, Logic minimization, Limitations of two-level synthesis, introduction to multi-level synthesis. **Module-II:** (L – 06) Programmable Logic Devices: Programmable Logic Array (PLA) architecture; Programmable Array Logic (PAL), PAL vs. PROM, Fan-in expansion feature, Architecture for sequential circuit implementation, Typical PAL chips; Complex Programmable Logic Devices (CPLD). **Module-III:** (L – 06) Programmable Gate Arrays: Gate Array concept, Mask programmable and Field Programmable						

	Gate Arrays; Lookup tables (LUT) Configurable logic blocks (CLB), logic design using LUT's; Multi-level synthesis techniques – Factoring and Functional decomposition, Shannon's Expansion Theorem; Generalized FPGA Architecture; Introduction to CAD Tools for FPGA based design, design entry, and simulation – introduction to HDL, synthesis, post-synthesis simulation, interfacing external devices. **Module-IV:** (L – 08) Sequential Circuit Design: Finite State Machines, Moore and Mealy Machines; State diagrams, State table, State assignment, derivation of next-state and output expressions, state minimization; State assignment for low power operation; CAD tools for FSM synthesis; Designing a simple CPU, concept of embedded system. **Module-V:** (L – 02) Advanced features of modern FPGAs: Block RAMs, Embedded processor, Communication ports, Analog interface. **Module-VI:** (L – 06) FPGA as a Hardware Debugging platform: Hardware troubleshooting methods, Looking into the chip – Logic State Analyzer and its use; Concept of Hardware emulation – simulation vs. Emulation, FPGA as a Hardware emulator, Break-points and their utility, setting break-points in FPGA based design. **Module-VII:** (P – 8) Familiarizing with CAD tools, Design and synthesis of simple logic functions – Basic gates, adder/subtractor, decoder, encoder, multiplexer, demultiplexer; Interfacing external devices – setting user constraint file, interfacing input (switch) and output (LED) devices, BCD to seven-segment decoder, keyboard/display interface; designing memory elements and arrays; sequential machine design – sequence generators, timing generators, a typical machine design (example: vending machine); A simple CPU design, constructing a basic embedded system – interfacing on-chip CPU, memory and I/O ports. **Module-VIII:** (P – 2) Design analysis: Static timing analysis, Power analysis, Resource utilization, noise, clock network, DRC, debugging methods.
Text Books, and/or Reference Materials	**Text Books**: 1. S. Brown and Z. Vranesic, "*Fundamentals of Digital Logic with Verilog Design,*" McGraw Hill Education Special India Edition (SIE), 2017. **Reference Book**: 1. J. Bhasker, "*A Verilog HDL Primer*", B.S. Publications, Hyderabad in arrangement with Star Galaxy Publishing, USA, 1999.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
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CO#1	2	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#2	2	2	2	2	1	2	1	1	1	1	1	1	3	2	2
CO#3	2	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#4	2	1	1	2	1	1	1	1	1	1	1	1	2	2	2

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Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE714	MEMS and Microsystems Technology	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	● CO1: **Understand** characteristics of MEMS system ● CO2: **Understand** basic building blocks of general MEMS systems ● CO3: **Understand** synthesis and fabrication of MEMS system ● CO4: **Apply qualitative and quantitative analysis** techniques in general MEMS systems ● CO5: **Design** techniques in MEMS ● CO6: **Investigate complex designs** in MEMS systems						
Topics Covered	Fabrication process (5L) Lumped Modeling, Statics, Dynamics (5L) Quasi static analysis (3L) Elasticity, Structures (4L) Energy Methods (3L) Thermal Energy Domain, Fluids, Electronics (6L) Noise (2L) Feedback systems (2L) Integration of MEMS systems, Scaling effect (3L) Reliability of MEMS devices (2L) Case studies in MEMS (7L)						
Text Books, and/or reference material	**Text Book**: 1. Microsystem Design by Stephen D. Senturia, Springer **Reference Book**: 1. Micro and Smart Systems by K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre G.K. Ananthasuresh, Wiley						

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#2	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#3	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO#4	1	3	2	1	1	1	1	1	1	1	1	1	2	3	1
CO#5	1	1	3	2	1	1	1	1	1	1	1	1	2	3	1
CO#6	1	2	3	1	1	1	1	1	1	1	1	1	2	3	1

Correlation levels 1, 2 or 3 as defined below:

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<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE715</td><td>Machine Learning</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods:
Continuous (CT), mid-term (MT), and End Assessment (EA)</td></tr>
<tr><td colspan="3">Introduction to Computing (CSC01)
& Computer Programming Languages like Python, C++, Matlab etc.</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After the completion of the course the student will be able to learn the following:
• CO1: Distinguish between, supervised, unsupervised and semi-supervised learning
• CO2: Apply the apt machine learning strategy for any given problem
• CO3: Implement various ways of selecting suitable model parameters for different machine learning techniques
• CO4: Modify existing machine learning algorithms to improve classification efficiency
• CO5: Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
• CO6: Study of various machine learning algorithms including deep learning</td></tr>
<tr><td>Topics Covered</td><td colspan="7">MODULE I INTRODUCTION [L=3]
Brief Introduction to Machine Learning, Supervised Learning ,Unsupervised Learning, Reinforcement Learning
Design a Learning System, Perspectives and Issues in Machine Learning ,Concept Learning
MODULE II REGRESSION [L=6]
Linear Algebra, Statistical Decision Theory, Regression & Classification, Bias – Variance, Linear Regression, Multivariate Regression
MODULE III NEURAL NETWORKS AND SUPPORT VECTOR MACHINE[L=8]
Multi-layer Perceptron , Training of Multi -layer feed forward neural network using back propagation algorithm ,Over-fitting of trained model, Radial Basis Functions neural network, Support Vector Machines
MODULE IV TREE AND UNSUPERVISED LEARNING [L=7]
Learning with Trees , Decision Trees , Constructing Decision Trees ,Classification and Regression Trees , Unsupervised Learning, Gaussian Mixture Models, K-means clustering Algorithm

MODULE V DIMENSIONALITY REDUCTION [L=6]
Dimensionality Reduction, Linear Discriminant Analysis, Principal Component Analysis

MODULE VISTUDY OF MACHINE LEARNING ALGORITHMS[L=12]
Extreme learning machine (ELM), Training and testing of ELM, Recurrent Neural Network(RNN) and long short-term memory (LSTM),Training a LSTM based RNN, Reinforcement Learning, Deep learning and Convolutional Neural Network(CNN).</td></tr>
<tr><td>Text Books, and/or Reference material</td><td colspan="7">Text Books:
1. StephenMarsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, “Machine Learning”, First Edition, McGraw Hill Education, 2013.</td></tr>
</table>

	3.Satish Kumar, " Neural Networks: A Classroom Approach", McGraw-Hill (India), 2013 4.Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms, "Cambridge University Press",2014
	Reference Books: 1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012. 2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", First Edition, Wiley, 2014 3. EthemAlpaydin, —Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014 4.Simon Haykin, "Neural networks and learning machines," Pearson,3rd edition,2009 5.Charu C.Aggarwal, "Neural Networks and Deep learning,"Springer,2018

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) & PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	1	1	2	1	1	1	1	1	1	2	3	2
CO#2	3	3	3	2	2	2	1	1	1	1	1	1	3	2	2
CO#3	3	3	2	2	2	1	2	1	1	1	1	1	3	3	2
CO#4	3	2	2	3	3	2	1	1	1	1	1	1	3	3	2
CO#5	3	2	2	2	2	2	1	1	1	1	1	1	3	2	2
CO#6	3	3	2	2	2	2	1	2	1	1	1	2	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE716</td><td>Millimeter wave Technology</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT), Mid-Term (MT) and End Assessment (EA))</td></tr>
<tr><td colspan="3">Electromagnetic Theory and Transmission Lines (ECC403),
Electronic Devices and Circuits I and II (ECC302, ECC504),
Microwave Engineering (ECC502)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO #1 Students will be able to learn the intricacies of design constraints at mm wave frequencies
• CO #2 The basic training for understanding circuit design at mm wave frequencies for our Country's defense and space applications would be enriched.
• CO #3 The students can design planar circuits and can provide reasoning for the obtained results.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction: mm wave spectrum, Typical applications of microwave and mm wave, Safety considerations. Difference in High frequency and relatively low frequency behaviour of Lumped circuit components. Miniaturization and design of Lumped components at millimetre wave frequencies. Realization of reactive elements as mm wave planar circuit components. (2H)
Review of Transmission line theory. Concept of Scattering Matrix N-port networks-Properties of S matrix, Transmission matrix and their relationships (4H)
mm wave Waveguide and Resonators
Rectangular Waveguide- design consideration, TE and TM modes, TE_{10} mode analysis, cut-off frequency, propagation constant, intrinsic wave impedance, phase and group velocity, power transmission, attenuation, waveguide excitation, wall current; Introduction of circular waveguide; Rectangular waveguide resonator design consideration, resonant frequency, Q-factor, excitation. (6H)
Planar Transmission lines and Resonators at mm Waves
Propagation characteristics, comparison for different characteristics of the above mentioned lines. strip line, micro-strip line, coplanar waveguide, Slot line-design consideration, Substrate integrated waveguide, non radiating dielectric guides, Design synthesis and analysis (6H)
Passive Components and their S-matrix Representation
Millimetre wave passive components and their S matrix representation: Attenuators, Phase shifter, Directional coupler, Bethe-hole coupler, magic tee, hybrid ring, circulators, Isolators; design of planar power dividers and couplers; design procedure of filter using insertion loss method-specification, low-pass prototype design, scaling and conversion, implementation. (8H)
mm wave devices and Application to switches and mixers
TED (Gunn diode) & Avalanche Transit Time (IMPATT) device, Schottky diode, PIN & applications; Microwave bipolar transistor, Microwave field effect transistor. (6H)
Microwave Amplifier Design at mm Waves
Basic consideration in the design of microwave amplifier- transistor S-parameter, Stability,</td></tr>
</table>

	matching network, noise figure; matching network design using lumped elements and L-Section. Design of LNA. (**6H)** **mm wave measurement basics** VSWR meter, tunable detector, slotted line and probe detector, spectrum analyzer, network analyzer, measurement of VSWR – low, medium and high, measurement of power: low, medium and high, frequency measurement.(**4H)**
Text Books, and/or reference material	**Text Books:** [1] David. M. Pozar, *Microwave Engineering*, 2/e, 1998 (John Wiley & Sons). [2] DrDuixian Liu, Mr Brian Gaucher, Dr Ulrich Pfeiffer, DrJanuszGrzyb, *Advanced Millimeter-Wave Technologies: Antennas, Packaging and Circuits*, 2009 John Wiley & Sons, Ltd [3] G H Bryant, *Principles of microwave Measurement*, London : P. Peregrinus Ltd. on behalf of the Institution of Electrical Engineers, c1988 **Reference Books:** [1] P A Rizzi, *Microwave Engineering: Passive Circuits*, 2000, PHI [2] R E Collin, *Foundations of Microwave Engineering*, John Wiley and Sons India Pvt. Ltd. [4] Noël Deferm Patrick Reynaert, *CMOS Front Ends for Millimeter Wave Wireless Communication Systems*, Springer International Publishing Switzerland 2015

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE717	RFID Technology and Applications	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous Assessment (CA), Mid-semester assessment (MA) and End Assessment (EA)):					
Signals and Systems (ECC303) Analog Communication (ECC401) Digital Communication (ECC501) Microwave Engineering (ECC502) Analog IC Design (ECE712)		Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination					

Course Outcomes	**CO#1** Ability to understand the basic knowledge of the radio frequency identification technology. **CO#2** Ability to analyze, explain and resolve technical problems related to RFID technology for skills. **CO#3** Develop an ability to forming, planning, deployment, operation, and evaluation systems using RFID technology and complete real models.
Topics Covered/ Syllabus	**Components Of RFID Systems And Performance Metrics**: Classification of RFID systems available, commercial specifications[L-6] **RFID Antenna and Tag Chip Design**:Design variants, developing matching elements, installation, environment [L-6] **Design of passive RFID tag**: Passive RFID Operation; Passive RFID Reader Design [L-6] **RFID Middleware**: Concepts and Architecture, Data Management and Application-Level Events [L-6] **TAG identification protocols**, Tree-Based Anti-Collision Protocols for RFID Tags, Comparison of TTF and RTF UHF RFID Protocols , Techniques of RFID Positioning[L-6] **Reader Infrastructure Networking**, Integrating RFID Readers in Enterprise IT, reducing interference in networks, Optimal Tag Coverage and Tag Report Elimination, Secure and Privacy-Enhanced RFID Systems, Cryptographic Approaches for Improving Security and Privacy Issues of RFID Systems [L-6] **Energy Harvesting for Self-Powered Autonomous RFID Systems**, Tag Architecture Based on Energy Harvesting, Simulators and Emulators for Different Abstraction Layers of UHF RFID Systems [L-6]
Text Books, and/or Reference material	**Text Books:** [1] R Ludwig and P Bretchko, *RF Circuit Design: Theory and Application*, Pearson Education, New Delhi [2] Miles S,SarmaS,Wiiams J., (Eds.) (2008),RFID Technology and Applications, Cambridge: Cambridge University Press. Doi: 10.1017/CBO9780511541155 **Reference Book:** [1] M. Bolic, D. Simplot-Ryl, I. Stojmenovic (Editors), *RFID Systems: Research Trends and Challenges*, John Wiley and Sons, 2010.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)														
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO# 4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO#2**	**PSO# 3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics & Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE718</td><td>VLSI System Design</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous Assessment (CA:15%), Mid-Term Assessment (MA:25%) and End-Term Assessment (EA:60%))</td></tr>
<tr><td colspan="3">VLSI Design (ECC602)</td><td colspan="5">Continuous Assessment (CA): Quizzes/Class tests/Assignments/Attendance</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After the completion of the course, the student will be able to
• CO 1: Understand the full custom and semi-custom design flow.
• CO 2: Learn about static timing analysis and design constraints.
• CO 3: Understand the design for testability flows.
• CO 4: Identify and interpret the design towards realizing VLSI design.
• CO 5: Design and analyse the performance (speed, power) of VLSI circuits and design for different specifications.
• CO 6: Evaluate and design of memory cell.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I. Overview of VLSI System Design [L – 2]
VLSI System design methodologies, VLSI design flow, Recent Trends in VLSI Design & its research issues in the industry: System case studies. Design automation of VLSI Systems: basic concepts. Deep Sub-micron Technologies: Some Design Issues.
Module II. Full Custom Flow [L – 6]
Block specification, schematic design entry, netlist generation and simulation, simulation for process and operating corners, layout with DRC/ LVS clean, parasitic extraction for R & C, back annotation & simulation, simulation redone with parasitic information, Concepts of PCELL.
Module III. Constraints and Static Timing Analysis[L – 8]
Basic tenets of synchronous static timing: setup & hold timing, multipath & false paths, clock skew & latency, Asynchronous and synchronous clocks, crossing clock domains & clock gating; Design constraints for a design in SDC format: design objects, timing constraints, environmental constraints, case analysis; timing report, synchronous static timing.
Module IV. Semiconductor Memories[L – 8]
Memory hierarchy and types; SRAM Cell optimization and design metrics, memory read and write path; DRAM array design and related constraints, DRAM interface- address decoding, pipelining, data interface, charge pumps; non-volatile memory cell-basic principle and operation, reliability considerations of NVM; Case study- high-speed memory, low voltage memory.
Module V. Design for Testability[L – 8]
Introduction to DFT, DFT directory structure, DFT rule checker, debugging and fixing DFT violations, scan Mapping, Scan mapping, scan chain connection, using pre-compiled cores, adding testability logic, ATPG, DFT flows.
Module VI. Flow for Designing Full SoC [L – 5]
Block specification, schematic design entry, netlist generation and simulation, simulation for process and operating corners, layout with DRC/ LVS clean, parasitic extraction for R & C, back annotation & simulation, simulation redone with parasitic information, concepts of PCELL.
Module VII. Physical Design [L – 5]
Floorplanning and placement, clock tree insertion & DFT insertion, routing, post</td></tr>
</table>

	PnRfunction & timing checks, interconnection architectures.
Text Books, and/or Reference Material	**Text Books:** 1. N. H. E. Weste and C. Harris, "*Principles of CMOS VLSI Design: A System Perspective"*, 3rd Edition, Pearson Education 2007. 2. Jan M. Rabaey, AnanthaChandrakasan, BorivojeNikolic, "*Digital Integrated Circuits: A Design Perspective*", Second Edition, Pearson Education, 2016. **Reference Books:** 1. Michael L. Bushnell, Vishwani D. Agrawal, "*Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits*", Kluwer Academic Publishers 2002. 2. Sung-Mo Kang, Yusuf Leblebici, "*CMOS Digital Integrated Circuits*", 3rd edition, Tata McGraw-Hill, 2003.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	1	2	1	1	1	1	1	1	3	3	2
CO#2	3	2	2	2	1	2	1	1	1	1	1	1	3	2	1
CO#3	3	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	3	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO#6	3	2	2	2	1	2	1	1	1	1	1	1	3	2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE719	Telecommunication Networks	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Analog Communication (ECC401), Digital Communication (ECC501)		CT+MT+EA					
Course Outcomes	CO#1: Learn about various types of networks appropriate for pre specified applications and operational scenarios. CO#2: Explain the information flow through various subsystems of a network. CO#3: Understand the current technology trends and business potential of future telecommunication networking paradigms.						
Topics Covered	Elements of telecommunication network. (2L) Computer networks. (8L) Landline telephone networks. (8L) Cellular mobile networks. (8L) Optical networks. (8L) Satellite networks. (8L)						

Text Books, and/or reference material	**Text Book:** 1. Communication Networks – J. Walrand. **Reference Books:** 1. Telecommunication Switching and Networks - P. Gnanasivam. 2. Optical and Wireless Communications – M. N.O. Sadiku.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	1	2	1	2	1	1	1	1	1	1	3	3	1
CO#2	3	2	3	1	1	1	1	1	1	1	1	1	3	3	1
CO#3	1	1	2	3	1	3	3	2	1	2	3	2	3	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Lecture (L)	Lecture (L)	Lecture (L)	
ECE720	Advanced Semiconductor Devices	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Physics of Semiconductor Devices (PHC331)		CT+MT+EA					
Course Outcomes	● **CO1**Understand state of the art in semiconductor device physics and electronic properties of semiconductor devices ● **CO2** Acquire in depthknowledge of advanced field effect transistors and its applications ● **CO3** Develop understanding about basic working principles of quantum well devices and heterojunction device simulations						
Topics Covered	**Module I: (L – 10)** Electronic properties and technologies of semiconductor Devices : SiGe and Group III-V compound semiconductors; Advanced Heterojunction bipolar Transistor (HBT) Devices: SiGe, GaAs, InP, GaN **Module II: (L – 10)** Advanced Field Effect Devices: Heterostructure Field Effect Transistors (HFETs), Modulation Doped Field Effect Transistors (MODFETs), High Electron Mobility Transistors (HEMTs) **Module III: (L – 4)** Resonant Tunneling Devices (RTDs); Single Electron Transistors (SETs) **Module IV: (L –10)** Strained layer superlattices and quantum well devices; RF & digital applications; Noise Characteristics **Module V: (L –8)** HBT Modelling; Heterojunction device simulation						
Text Books,	1. Theory of Modern Electronic Semiconductor Devices, Kevin F. Brennan, April S. Brown, 2002 John Wiley & Sons, Inc.						

and/or reference material	2. Physics of Semiconductor Devices, S.M. Sze, Wiley, 1981 3. GaAs High-Speed Devices: Physics, Technology, and Circuit Applications, C.Y. Chang, F. Kai, Wiley, 1994 4. Device Electronics for Integrated Circuits, R. S. Muller & T. I. Kamins, Wiley, 2003 5. Silicon VLSI technology: fundamentals, practice and modelling, J. D. Plummer, M. D. Deal, P. B. Griffin, Pearson Education, 2009

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	-	-	-	-	-	-	-	2	3	2	2
CO#2	2	2	3	2	3	-	1	-	-	-	1	3	2	2	3
CO#3	2	2	3	2	1	-	-	-	-	-	-	2	2	2	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE721	Random Process	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT),End Assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	• CO1: Characterize probability models and function of random variables. • CO2: Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits. • CO3: Recognize, interpret and apply a variety of deterministic and nondeterministic random processes that occur in engineering. • CO4: Calculate the autocorrelation and spectral density of a random process and recognize the relation beteen them.						
Topics Covered	7. Introduction: Basic of Probability theory, Bernoulli's Trials (5L) 8. Random Variables: PDF, PMF, Function of one random variable,Mean, Variance, Moments, Characteristics functions of random variables (10L) 9. Two random variables, Joint density and distribution function, Two functions of two random variables (8L) 10. Stationary random processes, Autocorrelation function, Cross correlation function, Covariance, PSD (7L) 11. Linear systems with random inputs (3L) 12. Markov Processes, Markov chain, CTMC, DTMC (4L) 13. Poisson process, Poissson distribution, Gaussian process (5L)						

Text Books, and/or reference material	**Text Books**: 5. A. Popoulis, U. Pillai, *Probability, random variables and stochastic processes*, Tata McGraw-Hill Inc., 4th Ed., New Delhi, 2017 6. P. Peebles, *Probability, random variables and random signal priniciples*, McGraw-Hill Inc., 4th Ed., New York, USA, 2001 7. C. W. Therrien, M. Tummala, *Probabilty and random processes for electrical and computer engineers*, 2nd Ed., CRC press, printed in India, 2012 **Reference Books**: 3. George R. Cooper, C. D. McGillem, *Probabilistic methods of signal analysis and system analysis*, Oxford University Press, 3rd Ed. , New Delhi, 2007 4. Alberto Leon-Garcia, *Probability and random processes for electrical engineering*, Pearson Education Inc., 2nd Ed., 2007

COURSE ARTICULATION MATRIX

Mapping the Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)														
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	2	2	1	1	1	-	1	1	2	3	3	1	2
CO#2	3	2	2	2	2	-	-	-	-	1	1	1	3	2	2
CO#3	3	2	2	3	2	-	-	-	-	-	-	1	3	2	1
CO#4	3	2	3	3	2	-	-	-	-	-	-	1	3	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 46				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE722	Microwave Circuits and Techniques	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) and End Assessment (EA))					
Microwave Engineering (ECC502)		CT+MT+EA					
Course Outcomes	● **CO#1** Students will be able to learn the intricacies of design constraints at high frequency. ● **CO#2**The students can design and synthesize planar circuits and can provide reasoning for the obtained results. ● **CO#3** The basic training for understanding planar passive and active circuit design at microwave frequencies for defense and space applications would be enriched.						
Topics Covered	**Introduction: RF & Microwave Spectrum, Typical applications of RF and Microwave, Safety considerations**. [L-2] **Review of Transmission line theory. Concept of Scattering Matrix; Smith Chart** [L-2] **Microwave Waveguide and Waveguide Resonator** [L-6] Rectangular Waveguide- Design consideration, TE & TM modes, TE10 mode analysis, cut-off frequency, propagation constant, intrinsic wave impedance, phase and group velocity, power transmission,attenuation, waveguide excitation, wall current; Introduction of circular waveguide; Rectangular waveguide resonator- Design						

	consideration, resonant frequency, Q-factor, excitation. **Planar Transmission Line** [L-4] Propagation characteristics, Comparison for different characteristics of the above mentioned lines. Micro-strip lines, Coplanar waveguide, Slot line-design consideration, field patterns. **High frequency Circuit Elements** [L-6] Difference in High frequency and relatively low frequency behaviour of Lumped circuit components. Miniaturization and Design of Lumped components at High RF. Realization of reactive elements as Waveguide and Planar Circuit components. **Planar Passive Components and their S-matrix Representation** [L-8] N-port networks-Properties of S matrix, Transmission matrix & their relationships; Microwave passive components and their S matrix representation: Attenuators, Phase shifter, Power dividers, couplers, impedance matching elements as well as filters. **Semiconductor Microwave Devices and Circuits** [L-6] TED (Gunn diode) & Avalanche Transit Time (IMPATT) device, Schottky diode, PIN & applications; Microwave bipolar transistor, Microwave field effect transistor (MESFET). **Microwave Amplifier Design** [L-6] Basic consideration in the design of RF amplifier- Transistor S-parameter, Stability, matching network, noise figure; Matching network design using lumped elements and L-Section. Design of LNA. **Microwave Circuit Measurement** [L-6] VSWR meter, Tunable detector, Slotted line and Probe detector, Frequency meter, Network analyzer, Measurement of VSWR – low, medium and high, Measurement of power: low, medium and high, Frequency measurement.
Text Books, and/or reference material	**Text Books**: [1] High Frequency integrated Circuits, SorinVoinigescu, Cambridge University Press, New Delhi 2013 [2] Microwave Engineering D M Pozar, John Wiley and Sons, New Delhi **Reference Books** [1] Microwave Integrated circuit, K. C. Gupta. [2] Microwave Devices & Circuits 3/e, Samuel Y. Liao. [3] Microstrip lines and Slot lines, K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, Artech House, Boston, 1996. [4] Microwave Integrated Circuits, By Ivan Kneppo, J. Fabian, P. Bezousek

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO# 2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO# 11	PO #12	PSO# 1	PSO# 2	PSO# 3
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:

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Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE723	Semiconductor Device Modeling	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Physics of Semiconductor Devices (PHC331), Electronic Devices and Circuits I (ECC302)		CT+MT+EA					
Course Outcomes	**CO 1:** To describe the essential properties of semiconductor materials **CO 2:** To analyse the carrier concentration as a function of temperature, doping and illumination conditions **CO 3:**To understand the transport of charge carriers for the operation of semiconductor devices. **CO 4:**To derive the physical model of P-N junctions. **CO 5:** To analyze the charge, electric field, potential and current distributions in the MOS devices **CO 6:**To develop the fundamental understanding of device modeling						
Topics Covered	**Module 1** **[6L]** Semiconductor Fundamentals: Equilibrium carrier concentrations (electron statistics, density of states, Effective Mass, Bandgap), Drift Velocity, Mobility and Scattering, Drift & Diffusion Current, Continuity equation. **Module 2** **[8L]** Metal-Semiconductor and PN Junction: Metal-Semiconductor junctions, Current-Voltage Characteristics, Surface Effect, Ideal static pnjuntionI-V characteristics, Diode Equation, Breakdown, Junction Capacitances **Module 3** **[6L]** MOS Capacitor: Modes of operation (accumulation, depletion, strong/weak inversion), Capacitance versus voltage (High ad Low Frequency), Flat Band Voltage, Nonideal effects (poly depletion, surface charges), **Module 4** **[6L]** Long Channel MOSFET Devices: Review of operation. Threshold Voltage Model, I-V Model **Module5** **[8L]** Short Channel MOSFET Devices: Scaling effects (short channel, narrow channel effects, drain induced barrier lowering), Channel velocity limitations (saturation velocity, interface scattering, mobility models). Subthreshold current, Hot carrier effects (impact ionization, gate/substrate currents, threshold voltage degradation, velocity overshoot, ballistic						

	effects) **Module 6** **[5L]** Advanced Devices: SOI, SiGe, strained Si, Alternative oxide/gate materials, Alternative geometries (raised source/drain, dual gate, vertical, FinFET), Tunnel FETs, Memory Devices (DRAM, Flash) **Module 7:** **[3L]** Introduction to BSIM Model: BSIM family of Compact device models, BSIM6 model
Text Books, and/or reference material	1. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, 2. S. M. Sze, Physics of Semiconductor Devices 3. S. M. Sze, Semiconductor Devices: Physics and Technology 4. Michael Shur, Physics of Semiconductor Devices, 5. NanditaDasGupta and AmitavaDasGupta, Semiconductor Devices, 6. C. T. Sah, Fundamentals of Solid State Electronics

COURSE ARTICULATION MATRIX

Mapping CO (Course outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO# 1	PSO #2	PSO #3
CO#1	2	1	1	1	1	1	1	1	1	1	1	2	3	2	1
CO#2	2	2	1	1	1	1	1	1	1	2	1	2	3	2	2
CO#3	2	3	2	2	2	1	1	1	1	2	1	2	3	2	2
CO#4	3	3	3	2	1	1	1	1	1	2	1	2	3	3	2
CO#5	3	3	3	3	3	1	1	1	1	2	1	3	3	3	3
CO#6	3	3	3	2	3	2	1	1	2	2	2	3	3	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE724	Biomedical Instrumentation	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous Assessment (CA), Mid-semester assessment (MA) and End Assessment (EA))					
Basic Electronics (ECC01), Engineering Mechanics (XEC01)		Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination					
Course Outcomes	After the completion of the course the student will be able to • **CO 1**: Understand concept of Biomedical Instrumentation • **CO 2**: Understand basic building blocks of Biomedical Instruments • **CO 3**: Apply quantitative analysis techniques to Biomedical Instruments • **CO 4**: Learn design techniques of Biomedical Instruments • **CO 5**: Investigate application specific Biomedical Instruments						
Topics Covered	**Module I: Introduction to Biomedical Measurements and Instrumentation [L-1]** **Module II: Static and dynamic characteristics of Biomedical Instruments [L-7]** Static characteristics of elements, Dynamic characteristics of elements, Quasi- static characteristics of elements, Static characteristics of systems, Dynamic characteristics of						

	systems, linearity, non-linearity, Sensitivity, Resolution, Repeatability, Reproducibility, Response time, Settling time, Gain, bandwidth **Module III: Error and Noise in Biomedical Measurements [L-4]** Sources of noise in measurement systems, mathematical modelling of noise, environmental effects, Effects of Interfering and Modifying inputs, Error analysis, Systematic error, Random error. Statistical methods for noise and error analysis and Modelling. **Module IV: Reliability analysis of Biomedical Instruments [L-4]** Concept of Reliability, Reliability of measurement systems, Reliability enhancement strategies **Module V: Operation of Physiological organs, Bioelectric Potentials and Electrodes [L-7]** Operation of Physiological organs, Operation of Nerves system, Operation of heart, Operation of lungs, Operation of Muscular system, Sources of bioelectric potentials, Bioelectric electrodes **Module VI: Building blocks of Biomedical Instruments [L-9]** Bioelectric sensors, Sensors, Signal conditioning circuits, Bridge circuits, Amplifiers, Filters, Oscillators, ADC, Signal Processing Units, Microcontrollers, Data Presentation elements **Module VII: Application Specific Biomedical Instruments [L-10]** Clinical thermometer, Sphygmomanometer, Digital Statoscope, ECG signal measuring instrument, EEG signal measuring instrument, Medical Imaging techniques, Assistive Respiratory system
Text Books, and/or reference material	**Text Books:** 1. John G. Webster, *Medical Instrumentation Application and Design*, 4ed, Wiley, 2015 2. J. Bentley, *Principles of measurement systems*. Pearson Education India; 3rd edition, 2002 3. R.S. Khandpur, *Handbook of Biomedical Instrumentation*, 3rd Edition, McGraw Hill Education;, 2014 **Reference Material:** 1. Research Articles

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome)
to
PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	-	-	-	-	2	-	-	-	-	-	-	3	-	-
CO#2	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO#3	1	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO#4	2	1	2	-	-	2	-	-	-	-	-	-	3	2	-
CO#5	1	1	1	3	-	2	-	-	-	-	-	-	2	1	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE725</td><td>Ad Hoc & Sensor Networks</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods
(Continuous (CT), Mid-Term (MT) and End Assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">●CO1 To understand the fundamentals of Wireless Adhoc and Sensor networks and its application

●CO2To study the various protocols at various layers and its differences with traditional protocols.

● CO3 Understanding Communication Theoretic aspects of Adhoc / Sensor Networks

●CO4 To learn about the issues and challenges in the design of wireless ad hocand Sensor Networks.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Fundamentals of wireless communication technology, Radio propagation, characteristics of wireless channels, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet. (4L)
2. Introduction to Adhoc/Sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering. (6L)
3.Communiation Theoretic Framework for Multihop Adhoc Networks: Topology, Route Discovery , Average no of Hops, Bit Error Rate of Multihop Route, Connectivity, Life Time, Network behaviour (8L)

4. MAC Protocols : MAC protocols for adhoc/sensor wireless networks, design goals, classification of MAC protocols, Schedule-Based and Random Access-Based Protocols, Sensor-MAC, Zebra-MAC MAC protocols for sensor network, Hybrid-TDMA/FDMA, CSMA based MAC, S-MAC, LEACH, IEEE 802.15.4. location discovery, quality, other issues, (10L)
5.Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols. (8L)

6.QoS and Energy Management : Issues and Challenges in providing QoS, classifications, MAC and network layer solutions, QoS frameworks, energy management. (6L)</td></tr>
</table>

Text Books, and/or reference material	**Text Books**: 1. C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education - 2008. 2. Ozan K.Tonguz and Gianluigi Ferrari, " Ad Hoc Wireless Networks" Wiley India **Reference Books**: 3. Feng Zhao and LeonidesGuibas, "Wireless sensor networks ", Elsevier publication - 2004. 4. Ian F. Akyildiz, Mehmet Can Vuran "Wireless Sensor Networks", Wiley 5. Chiara Buratti, Marco Martalò, Gianluigi Ferrari, Roberto Verdone, " Sensor Networks with IEEE 802.15.4 Systems, Distributed Processing, MAC and Connectivity

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	2	2	1	1	1	1	1	1	1	3	2	3
CO#2	3	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO#3	3	3	3	2	1	1	2	1	1	1	1	1	3	2	2
CO#4	3	3	3	2	1	1	2	1	1	1	1	1	3	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

EIGHTH SEMESTER

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE810</td><td>Wireless Communication</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT), Mid-Term (MT) and End Assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On successful completion of this course, students should have the skills and knowledge to :

CO1. Apply Cellular concepts to evaluate the signal reception performance in a cellular network and traffic analysis to design cellular network with given quality of service constraints.
CO2. Determine the type and appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium.
CO3. Analyze and design receiver and transmitter diversity techniques.Determine the appropriate transceiver design of multi-antenna systems and evaluate the data rate performance.
CO4. Application of Fundamental Digital Communication Concepts in Fading Channel.
CO5. Understanding suitable Modulation Schemes and Multiple access forWireless Communication.
CO6. Describe and differentiate four generations of wireless standard for cellular networks.Understand wireless communication systems with key 3G (e.g., CDMA) and 4G (OFDM) technologies.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="7">1. Introduction to Wireless Personal Communication, Mobile radio systems.(02 hrs)
2. Cellular systems concepts, principles, system design fundamentals, spectrum efficiency, frequency management, channel assignment, handoff, power control, Call blocking, Erlang B, Cell splitting and Directional antenna etc(06 hrs)
3. Characterization of wireless radio channel, propagation path models. Fading and Shadowing, Statistical Characterization of fading Channel (08 hrs)
4. Receiver Techniques for fading Channel: Detection of Signal in Fading Channel, Diversity Techniques, Time and Frequency Diversity, Receive Diversity(SC, MRC, EGC, Switch & Stay), BER and outage with Diversity, Equalization, Fading mitigation (10 hrs)
5. Modulation schemes for wireless Communication (MSK, GMSK), OFDM (07hrs)
6. Multiple access techniques: TDMA, FDMA, spread spectrum techniques, Cellular CDMA, Wide-band CDMA, Multiple access Performance of CDMA, Capacities of multiple access schemes, comparison. (06 hrs)
7. Wireless Networks and Standards: GSM, CDMA cellular standard, 3G, 4G(03 hrs)</td></tr>
<tr><td rowspan="2">Text Books, and/or Reference material</td><td colspan="7">Text Books:
1.Wireless Communications: Principles and Practice: Theodore Rappaport, Pearson, 2nd Edition.
2.Wireless Communication: Andrea Goldsmith, Cambridge University Press.</td></tr>
<tr><td colspan="7">Reference Books/Materials:
1. Principles of Modern Wireless Communication Systems Theory and Practice: Aditya K Jagannatham, McGraw-Hill India.
2. Fundamentals of Wireless Communication: David TSE and PramodViswanathan, Cambridge University Press</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	2	2	1	1	2	1	1	1	1	1	1	3	2	2
CO#2	3	3	3	2	1	2	1	1	1	1	1	1	2	2	2
CO#3	3	3	3	2	1	2	2	1	1	1	1	1	3	3	2
CO#4	3	3	3	2	1	2	1	1	1	1	1	1	3	3	2
CO#5	3	3	3	2	1	2	1	1	1	1	1	1	3	2	3
CO#6	3	3	3	2	2	2	1	1	1	1	1	1	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics & Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE811	Mixed Signal IC Design	PEL	3	0	0	3	3
Pre-requisites			Course Assessment methods: (Continuous Assessment (CA), Mid-semester assessment (MA) and end assessment (EA))				
Analog IC Design (ECE712) Digital IC Design (ECE622)			Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination				

Course Outcomes

After the completion of the course, the student will be able to:

- **CO1:** Explain the operation of various High performance OTAs/Opamps.
- **CO2:** Design Analog Circuits using gm/ID techniques.
- **CO3:** Create the Layout of a CMOS Mixed Signal System.
- **CO4:** Analyze a Comparator.
- **CO5:** Interpret the use of Switched Capacitor Circuits in Sampled data Systems
- **CO6:** Compare Data converter architectures based on Area/Power/Speed.

Topics Covered

Module I. Introduction [L – 9]

Overview of Mixed-Signal Design flow. Design of high performance Fully Differential Opamps: Telescopic cascode, Folded cascode, two-stage, Rail-to-Rail, Gain boosted OTAs/Opamps, Comparison.

Module II. g_m over I_D Design Process [L – 4]

g_m over I_D technique: Transconductor efficiency in subthreshold, moderate and strong inversions. Various design plots: g_m/I_D, g_m/g_{ds}, f_T etc., and their use in Analog Design. Design of a CS Amplifier, and Two stage Opamp using g_m/I_D technique.

Module III. Opamp performance Metrics:[L – 2]

Slew rate & Settling time, CMRR, PSRR, Linearity, Distortion, Offset Cancellation techniques.

Module IV. Layout Techniques[L – 3]

Layout Techniques: Introduction to CMOS process, CMOS Layers, Design rule basics, DRC, LVS, Passive and Transistor layout, Fingering, Interdigitization. Matching components: Common centroid, Use of Dummy. Matching error, error propagation.

	Module V. Switched Capacitor Circuits [L – 5] Basic philosophy of Switched capacitor circuits, design of switched-capacitor amplifiers and integrators, effect of opamp finite gain, bandwidth and offset, circuit techniques for reducing effects of opamp imperfections, switches and charge injection and clock feed-through effects. **Module VI. Sample and Hold[L – 4]** Operation of sample and holds circuits and theirs non-idealities. Comparators: Opamp based, Strong Arm Regenerative Latch, Latch dynamics, Offset reduction. **Module VII. Data Converters [L – 12]** Fundamentals of data converters; Introduction to data converter metrics: SNR, DNL, INL, Offset & Gain Error, SINAD, ENOB, SFDR, SDNR, Settling time etc. Nyquist rate D/A converters - voltage, current and charge mode converters, hybrid and segmented converters. Nyquist rate A/D converters (Flash, interpolating, folding flash, SAR and pipelined architectures) **Module VIII. Phase Locked Loop [L – 3]** Basic PLL topology, dynamics of simple PLL, Multiplier, phase detectors, lock acquisition, Phase frequency detector, Loop filters, Charge Pump PLLs.
Text Books, and/or Reference materials	**Text Books:** 1. BehzadRazavi, "*Design of Analog CMOS Integrated Circuits*", McGraw Hill, 2nd Ed. 2017 2. Tony Chan Carusone; David Johns; Kenneth Martin, "*Analog Integrated Circuit Design*", Wiley, 2nd Ed. 2013, 3. BehzadRazavi, "*Principles of Data Conversion System Design*", Wiley-IEEE Press, 1994 4. Adel Sedra , Kenneth SmithTony Chan Carusone, Vincent Gaudet, "*Microelectronic Circuits*", Oxford ; 8th Ed.; 2020 **Reference Books/Materials:** 1. R.Gregorian, "*Introduction to CMOS Opamps and comparators*", Wiley, 1999 2. Rudy J. Van De Plassche, "*CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters*", Springer, 2nd Ed. 2003. 3. Ali Hajimiri, Caltech, "*New Analog Circuit Design",*https://www.youtube.com/watch?v=403CnTftB4M&list=PLc7Gz02Znph-c2-ssFpRrzYwbzplXfXUT

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#3	3	3	3	1	1	1	1	1	1	1	1	1	3	3	2
CO#4	1	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	2	3	1	2	1	2	2	1	1	1	1	1	2	3	2
CO#6	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
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<table>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE812</td><td>Broadband Communication</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods
(Continuous (CT), Mid-Term (MT), End Assessment (EA))</td></tr>
<tr><td colspan="3">Analog Communication (ECC401),
Digital Communication (ECC501)</td><td colspan="5">The assessment methods comprise of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: Understand the evolution, current state and tendency of broadband communication networks.
CO2: Learn the technologies and protocols behind broadband communication networks.
CO3: Learn the existing access technologies.
CO4: Acquire the capacity of solving problems related to the design, configuration and deployment of broadband communication networks.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Course Introduction– [4L]
Components of Broadband Communication Systems; Communications Network Architecture; Cable Broadband Data Network Architecture; Importance of Broadband Network Architectures; Future of Broadband Telecommunications; Internetworking.
Internet based Networks – [6L]
Internet Protocol Suite; IPv6 standard; Voice over IP; Internet Security; Flow Control; Intranet and Extranet Technologies and Applications; Intranet and Extranet Design Issues.
Networking Technologies– [8L]
X.25 and Frame Relay; Fiber Channel Technology and Topologies; Synchronous Optical Network (SONET), Synchronous Digital Hierarchy (SDH), Next-Generation SONET (NGS); Virtual Private Network-Types, General Architecture, Advantages and Disadvantages, Security Issues; ISDN and BISDN, ATM Networks and Applications.
Access Networks– [8L]
Digital Subscriber Line (DSL) Systems- Asymmetric Digital Subscriber Lines (ADSL), Symmetric Digital Subscriber Lines (SDSL), High Data Rate Digital Subscriber Lines (HDSL), Very High Data Rate Digital Subscriber Lines (VDSL); Cable Modem Systems- Technology, External and Internal Modems; Passive Optical Networks (PON)- Types, Advantages and Disadvantages of TDM PONs, Security Issues; Broadband over powerline.
Wireless Networks – [8L]
Wireless LAN; Wireless ATM; Cellular Communications; WiMAX; Satellite Communication- Types, Orbital and Propagation Characteristics, VSAT Networks, Satellite Radio, Satellite based Internet.
Network Management and Security– [8L]
Simple Network Management Protocol (SNMP); Management Information Base (MIB); Remote Network Monitoring (RMON); Network Threats and Security Requirements; Cryptography; Firewalls; Intrusion Detection; Security Standards- IPSec, DES.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. Cajetan M Akujuobi, Matthew N O Sadiku, “Introduction to Broadband Communication Systems”, Boca Raton, Fla. Chapman & Hall/CRC Raleigh, NC SciTech.
2. Lorne G Mason, Augusto Casaca, “Broadband Communications”, IFIP Advances in Information and Communication Technology, Springer.
Reference Book:Preston C Russett, James W Chesebro, David T McMahan, “Internet Communication”, series by Digital Formations.</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) and PO (Programme Outcome)

PO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	1	1	1	2	1	1	1	1	2	1	2	3	2	1
CO#2	2	2	2	2	2	1	2	1	1	3	1	2	3	2	2
CO#3	2	2	2	2	2	1	2	1	1	3	1	2	3	2	2
CO#4	2	2	2	2	3	2	3	2	1	2	2	3	2	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE813	Digital Image Processing	PEL	3	0	0	3	3

Prerequisites	Course Assessment methods (Continuous (CT), Mid-Term (MT), End Assessment (EA))		
Signals and Systems (ECC 303), Digital Circuits and Systems (ECC402), Digital Signal Processing (ECC603)	The assessment methods consist of quizzes, multiple choice type questions involving real world examples, and subjective questions all either designed in google form or assessed through pen and paper.		
Course Outcomes	● CO1: Understand image enhancement and restoration techniques. ● CO2: Analyze digital images through multiresolution techniques. ● CO3: Understand the application of morphological processing and segmentation in digital images. ● CO4: Ability to interpret digital image recognition techniques.		
Topics Covered mapped to Course Outcomes	Topic Details	(No. of classes)	Course Outcomes (COs)
	Digital Image Fundamentals: Image acquisition, Sampling, Quantization, Resolution, Relationship between pixels, Geometric transforms, Convolution and Correlation.	4	CO#1
	Image Enhancement: Gray level intensity transforms, Histogram processing, Image sharpening and smoothening operations (spatial and frequency based).	6	CO#1
	Image Restoration: Model of image degradation, Noise models, Restoration in the presence of noise only spatial filtering, Periodic noise reduction by frequency domain filtering, Estimating the degradation function, Weiner filtering, Constrained least squares filtering, Image interpolation and resampling.	6	CO#1
		6	CO#2,CO#

	Multi-resolution Image Processing: Short time Fourier transform, Wavelet function, Wavelet series, Discrete wavelet transform and multi-resolution analysis, Image decomposition and compression using discrete wavelet transform.	5	4
	Compression and Encoding of Image: Redundancy, Entropy coding, Lossy compression, Lossless compression, Quality preserving adaptive compression.	5	CO#1, CO#4
	Morphological Processing: Dilation and erosion, Opening and closing, Hit or Miss transform, Algorithms for feature extraction.	6	CO#3, CO#4
	Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation, Segmentation by morphological watersheds, Use of motion in segmentation.	4	CO#3, CO#4
	Patterns in Images and their Applications: Basics of features, Principal component analysis, Decision tree and feature hierarchy, Scale invariant feature transform, Histogram of oriented gradient.		CO#4
Text Books, and / or reference material	**Text Books**: 1. Digital Image Processing: R C Gonzalez and R E Woods; Pearson Education. 2. Guide to Signals and Patterns in Image Processing- Foundations, Methods and Applications: Apurba Das; Springer. 3. Digital Image Processing and Computer Vision: Sonka, Hlavac and Boyle; Cengage Learning (India Edition). **Reference Books**: 1. Digital Image Processing: K R Castleman; Pearson Education. 2. Digital Image Processing: S Sridhar; Oxford Higher Education.		

COURSE ARTICULATION MATRIX

Mapping of Course Outcome (CO) to Programme Outcome (PO) & Programme Specific Outcome (PSO)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO #2**	**PSO #3**
CO#1	3	3	3	3	3	-	-	-	2	-	1	-	3	3	1
CO#2	3	3	3	3	3	-	-	-	2	-	1	-	3	3	1
CO#3	2	3	3	3	2	-	-	-	1	-	1	-	3	3	1
CO#4	2	2	3	3	3	-	-	-	2	-	1	-	3	3	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 46				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE814	Error Control Coding	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Digital Circuits and Systems (ECC402),Digital Communication (ECC501)		CT+MT+EA					
Course Outcomes	**CO1:Acquire** idea about different types of error control coding techniques. **CO2:Understand** generator matrix, encoding and decoding of different codes. **CO3:Learn** LDPC, BCH, RS and Turbo codes. **CO4:Analyze** and mitigate errors in channels. **CO5:Differentiate** between different coding strategies.						
Topics Covered	1. Introduction to Linear Algebra: Group, Ring, Field, Vector Space. [L-7]2. Binary Linear Block Codes : Generator and Parity Check Matrices, Dual Codes, Decoding, General properties of linear block codes, Hamming Code. [L-9] 3.Cyclic Codes: Algebraic description, Encoding and Decoding of Cyclic codes. [L-7] 4. BCH Codes: Properties, Encoding and Decoding. Examples [L-4] 5. Reed Solomon (RS) Codes: Definition, Decoding of RS codes. Examples [L-4] 6. Convolution Codes: Definition, Encoding Trellis and State representation, Viterbi decoding, Error probability. [L-8] 7. LDPC Codes : Definition, Construction, Regular and irregular LDPC, Belief Propagation, Tanner Graph, Decoding, Iterative Decoding. [L-4] 8.Turbo Codes: Definition, Construction methods, Decoding; Polar codes. [L-3]						
Text Books, and/or reference material	**Text Books**: 1.Shu Lin and Daniel.J.Costello Jr. ,*Error Control Coding; Fundamentals and applications:* 2nd Ed., Pearson India, New Delhi, 2010. 2.J. C. Moreira and P. G. Farrel, *Essentials of Error Control Coding,* 1st Ed., Wiley India, 2006 **Reference Book**: Todd.K. Moon, *Error Correction Coding: Mathematical Methods and Algorithm,*1stEd.,Wiley India, New Delhi, 2005.						

COURSE ARTICULATION MATRIX

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	1	1	1	1	-	1	-	-	1	-	1	2	2	2
CO#2	2	2	2	2	1	-	-	-	-	-	-	1	3	2	2
CO#3	2	2	1	2	1	-	1	-	-	1	-	1	2	3	2
CO#4	3	1	3	2	2	-	-	-	-	-	-	1	3	2	2
CO#5	1	1	2	1	1	-	-	-	-	-	-	1	2	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE815</td><td>Embedded System Design</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous Assessment (CA), Mid-semester assessment (MA) and End Assessment (EA)):</td></tr>
<tr><td colspan="3">Basic Electronics (ECC01),
Introduction to Computing (CSC01),
Digital Circuits and Systems (ECC402),
Microprocessors and Microcontrollers (ECC503)</td><td colspan="5">Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After the completion of the course the student will be able to
• CO 1: Understand use of Microprocessor in Microcontrollers and Microcomputer
• CO 2: Interface I/O devices with Microprocessor in Microcontrollers and Microcomputer
• CO 3: Design software-controlled hardware systems
• CO 4: Investigate application specific embedded systems</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I: Intel 8051 Microcontroller[L-4]
Architecture of Intel 8051 Microcontroller using functional blocks, Crystal oscillators, Digital I/O Pins, Digital I/O ports, 8051 Microcontroller programmer, limitations of Intel 8051 Microcontroller.
Module II: ATmega Microcontrollers and Arduino[L-4]
Architecture of ATmega Microcontrollers using functional blocks, Hardware components of Arduino boards, ADC, Analog input pins, Digital I/O pins, PWM signals, PWM pins, Serial communication pins, Arduino shields, Limitations of ATmega Microcontrollers and Arduino.
Module III: Raspberry Pi Micro-Computer [L-4]
ARM processor, Hardware components of Raspberry Pi Micro-computer, GPIO pins in Raspberry Pi board, PWM signals, Raspberry Pi OS, In-built data communication devices, Limitations of Raspberry Pi Micro-Computer.
Module IV: I/O devices for Micro controllers and Microcomputers [L-5]
Sensors, Resistive sensors, Capacitive sensors, Inductive sensors, Actuators, Motors, Signal conditioning circuits, Amplifiers, Filters, Display elements, Data storage devices, Compatibility of several transducers with Intel 8051 Microcontroller, ATmega Microcontrollers and Arduino, Raspberry Pi Micro-Computer
Module V: Embedded System Programming using Keil [L-7]
Keil editor and compiler, Keil Programming for Intel 8051 Microcontroller, Program uploading to 8051 Microcontroller, I/O programming, Interfacing Analog and Digital sensors and actuators with Intel 8051 Microcontroller, Interrupt programming in 8051, Keypad and Display element interfacing with 8051.
Module VI: Embedded System Programming using Arduino language [L-7]
Arduino editor and compiler, Arduino Programming, Program uploading to Arduino board, I/O programming, Interfacing Analog and Digital sensors and actuators with Arduino, Serial communication and Data transmission in Arduino, Interrupt programming in Arduino, Keypad and Display element interfacing with Arduino.
Module VII: Embedded System Programming using Python[L-7]
Raspberry Pi OS, Python programming, Interfacing Analog and Digital sensors and</td></tr>
</table>

	actuators with Raspberry Pi, I/O programming in Raspberry Pi, Serial communication and Data transmission in Raspberry Pi, Interrupt programming, Keypad and Display element interfacing with Raspberry Pi. **Module VIII: Case studies [L-4]** Application specific embedded system design using 8051 Microcontroller, Arduino, Raspberry Pi, Password lock device using Embedded system, Smart home using embedded system, Motor controller using Embedded system
Text Books, and/or reference material	**Text Books:** 1. T. Givargis, F. Vahid , *Embedded System Design: A Unified Hardware / Software Introduction*, Wiley; Student edition, 2006 2. E. A. Lee, S. A. Seshia, *Introduction to Embedded Systems - a Cyber Physical Systems Approach*, PHI Learning Pvt Ltd, MIT Press; Second edition, 2019 3. M. A. Mazidi, *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, Pearson Education India; 2nd edition, 2007 **Reference books:** 1. J. Bentley, *Principles of measurement systems*. Pearson Education India; 3rd edition, 2002 2. T. W. Schultz, *C and the 8051, Vol.I: Hardware, Modular Programming & Multitasking*, Prentice Hall; 2nd edition, 1997 3. S. Monk, *Programming Arduino: Getting Started with Sketches*, Second Edition, McGraw-Hill, 2nd edition, 2016 4. J. Yiu, *The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors*, Newnes; 3rd edition, 2013 5. S. Monk, *Raspberry Pi Cookbook: Software and Hardware Problems and Solutions,*Shroff/O'Reilly; Second edition, 2016 6. D. Molloy, *Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux*, Wiley; 1st edition, 2016 7. Research Articles

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	3	-	-	-	-	2	-	-	-	-	-	-	3	-	-
CO#2	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO#3	1	3	-	1	-	-	-	-	-	-	-	-	3	2	-
CO#4	1	1	-	3	-	2	-	-	-	-	-	-	3	1	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 50				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE816	RF and MMIC	PEL	3	0	0	3	3
Pre requisite			Course Assessment methods: (Continuous Assessment				

	(CA), Mid-semester assessment (MA) and end assessment (EA)):
Electromagnetic Theory and Transmission Lines (ECC403), Electronic Devices and Circuits I and II (ECC302, ECC504), Microwave Engineering (ECC502)	Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination
Course Outcomes	●**CO1:**Grasp the in-depth account of GaAs, InP and SiGe, technologies and able to describe all the key techniques for the design ●**CO2:** Understand circuit design issues at RF and microwave frequencies for integrated circuit design for transceiver ●**CO3**: Assimilate the characterization of RF and microwave monolithic integrated circuits
Topics Covered	**Introduction to RFIC and MMIC: [L – 6]** Introduction to microwave integrated circuit (MIC), RF , microwave, mm wave and sub mm wave spectrum, history, applications and technology of MMICs Advantages and disadvantages of MMIC; enhancement of device technology that have contributed to RGIC and MMIC; Transceiver architectures, concept of IIP, nonlinearities, dynamic range and system noise **Review of Transmission line theory. Concept of Scattering Matrix[L – 4]** N-port networks-Properties of S matrix, Transmission matrix and their relationships **Microwave and mm wave Waveguide and Resonators [L – 4]** Rectangular Waveguide- design consideration, TE and TM modes, TE_{10} mode analysis, cut-off frequency, propagation constant, intrinsic wave impedance, phase and group velocity, power transmission, attenuation, waveguide excitation, wall current; Introduction of circular waveguide; Rectangular waveguide resonator design consideration, resonant frequency, Q-factor, excitation. **Planar Transmission lines and Resonators [L – 4]** Propagation characteristics, comparison for different characteristics of the above mentioned lines. strip line, micro-strip line, coplanar waveguide, Slot line-design consideration, Substrate integrated waveguide, non radiating dielectric guides, Design synthesis and analysis **Passive Components and their S-matrix Representation [L – 6]** Microwave and mm wave passive components and their S matrix representation: Attenuators, Phase shifter, Directional coupler, Bethe-hole coupler, magic tee, hybrid ring, circulators, Isolators; design of planar power dividers and couplers; design procedure of filter using insertion loss method-specification, low-pass prototype design, scaling and conversion, implementation. **Devices for RFIC and MMIC [L – 4]** CMOS, SOICMOS, GaAs, GaN and SiGe transistor technology **Amplifier Design [L – 6]** Basic consideration in the design of microwave amplifier- transistor S-parameter, Stability, matching network, noise figure; matching network design using lumped elements and L-Section. Five major MMIC amplifier topologies: the reactively matched amplifier, the lossy match amplifier, the feedback amplifier, the distributed amplifier and various forms of actively matched amplifier; design of low noise and high power amplifiers **Oscillator , Mixer, Switches, Attenuator and Phase Shifter [L – 8]**CAD techniques for large-signal oscillator design; phase noise; MMIC VCO design; and MMIC injection-locked oscillator design, analysis of mixer circuits; diode mixers; coupling structures; active FET mixers; resistive FET mixers; image-rejection mixers; single-sideband mixers; sub-harmonically pumped mixers; and distributed FET mixers.GaAs FET switch mechanism and the development of an equivalent circuit for switching operation; different schemes for the

	realization of GaAs MMIC variable attenuators; MMIC phase shifters, implemented under either analogue or digital control. **Integrated Antenna:[L-4]**monolithic integrated antennas; integrated antenna selection; substrate choice; measurement issues; packaging; photonic bandgap antennas; micromachined antennas, including trench and cavity etching; and microelectromechanical systems antennas **Microwave and mm wave measurement basics [L – 4]** VSWR meter, tunable detector, slotted line and probe detector, spectrum analyzer, network analyzer, measurement of VSWR – low, medium and high, measurement of power: low, medium and high, frequency measurement.
Text Books, and/or reference material	**Text Books:** 1. I D Robertson; S Lucyszyn, *RFIC and MMIC design and technology*, IET circuits, devices and systems series, 13 2. SorinVoinigescu,*High Frequency Integrated Circuits*, Cambridge UniveityPress,UK, 2013G 3. R Ludwig and P Bretchko, *RF Circuit Design: Theory and Application*, Pearson Education, New Delhi. 4. David. M. Pozar, *Microwave Engineering*, 2/e, 1998 (John Wiley & Sons). 5. H Bryant, *Principles of microwave Measurement*, London : P. Peregrinus Ltd. on behalf of the Institution of Electrical Engineers, c1988 **Reference Books:** 1. P A Rizzi, *Microwave Engineering: Passive Circuits*, 2000, PHI 2. R E Collin, *Foundations of Microwave Engineering*, John Wiley and Sons India Pvt. Ltd.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	2	3	1	1	2	1	1	2	2	2	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics & Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE817	Design with Op-Amp & Analog Int. Circuits	PEL	3	0	0	3	3
Pre-requisites			Course Assessment methods: (Continuous Assessment (CA), Mid-term Assessment (MA) and End-term Assessment (EA))				

Electronic Devices and Circuits I and II (ECC302, ECC504)	CA comprises of : Assignment(s), Quiz(zes) /Class test(s)
Course Outcomes	After the completion of the course the student will be able to • **CO1:**Define various parameters/terms associated with Operational Amplifier. • **CO2:**Describe the internal structure of an Opamp using functional blocks • **CO3:**Design Adder/Subtractor/Integrator/Differentiator using Opamps • **CO4:**Define Slew rate and estimate settling time. • **CO5:**Explain the operation of a DAC. • **CO6:**Analyze the operation of an ADC.
Topics Covered	**Module I. Introduction to Operational Amplifier [L – 7]** Basic Op-amp characteristics, DC characteristics, Unity Gain Frequency, CMRR, PSRR, offset voltages and currents, Input and output impedances, Slew rate and Frequency limitations. Ideal opamp circuit analysis. Amplifiers: inverting/non-inverting, Summing amplifiers, and Difference amplifiers. Integrator and differentiator. Understanding negative feedback, concept of virtual short. **Module II. OpAmp Circuits [L – 6]** Current to Voltage and Voltage to Current converters, Current Amplifiers, Difference Amplifiers, Instrumentation Amplifiers. Log/Antilog Amplifiers, Transducer bridge Amplifiers. **Module III. Active Filters [L – 7]** Filter classification and transfer functions, First order active filters, Audio filter applications, Second order filter responses, KRC filters, State variable and bi-quad filters. Sensitivity. Filter approximations, Cascaded design **Module IV. Non liner Circuits using OpAmp [L – 6]** Voltage comparators and applications, Schmitt Trigger, Precision rectifiers, Peak detectors, Sample and Hold amplifiers. Mutivibrators, Triangular wave generators, V to F and F to V converters **Module V. Voltage references and Regulators [L – 6]** General performance considerations, Voltage references, Linear regulators and Switching regulators Voltage mode control and current mode control. **Module VI. Data Converters [L – 7]** Performance specifications, Digital to Analog Conversion techniques, Multiplying digital to analog converter applications. Analog to Digital Conversion techniques, Flash, SAR, Dual-slope ADC operation. **Module VII. Phase Locked Loop[L – 3]** Basic operation of PLL, Block diagram, performance parameters, applications.
Text Books, and/or Reference materials	**Text Book:** 1. Sergio Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", McGraw-Hill, 2017. **Reference Book:** 1. Ramakant A Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson, 4th Edition 2015.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#3	3	2	3	1	1	1	1	1	1	1	1	1	2	3	2

CO#4	1	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	1	3	1	2	1	2	2	1	1	1	1	1	2	2	2
CO#6	3	2	2	2	1	1	1	1	1	1	1	1	2	3	2

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE818</td><td>Satellite Communication</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods
(Continuous (CT), Mid-Term (MT) and End Assessment (EA))</td></tr>
<tr><td colspan="2">Electromagnetic Theory and Transmission Lines (ECC403), Microwave Engineering (ECC502),Analog and Digital Communication(ECC401, ECC501),Antennas and Wave Propagation (ECC601)</td><td colspan="6">Assignments, Mid Semester and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO#1 To compute the satellite orbit parameters, design orbits and be able to classify them based on Kepler’s six elements.
CO#2 Understand the concept of satellite launching and positioning of satellites in orbits
CO#3 Can do computations of link design and classify different losses in propagation for space communication.
CO#4 Assimilate the concept of multiple accessing techniques in satellite communication.
CO#5 Develop ability to classify different types of application of satellite communication.</td></tr>
</table>

Topics Covered	**Introduction** Basic concepts, Frequency allocation for satellite services, orbital & spacecraft problems, comparison of networks and services, modulation techniques used for satellite communication. Spectrum Management**[L-4]** **Orbits** Two body problems, orbital mechanics, geostationary orbit, change in longitude, orbital manoeuvres, orbital transfer, and orbital perturbations. Launch Vehicles- principles of Rocket propulsion, powered flight, Lauch vehicles for communication satellite **[L-10]** **Satellite subsystems and satellite link design** Altitude and orbit control (AOC) Subsystem, TT&C, power system, spacecraft antenna, transponder, Friis transmission equation, G/T ratio of earth station.**[L-8]** **RF link-** noise, the basic RF link, satellite links (up and down) , optimization RF link, inter satellite link, noise temperature, Antenna temperature, overall system temperature, propagation factors, rain attenuation model. Tropospheric and Ionospheric effect.**[L-8]** **Multiple access** FDMA, TDMA, CDMA techniques, comparison of multiple access techniques, error connecting codes.**[L-8]** **Application of satellite** in remote sensing and surveillance; Basic of remote sensing, Electromagnetic Radiation principles, Atmospheric window, Indian satellite sensing satellite system, Active, Passive, ground based and space based remote sensing. **[L-8]**
Text Books, and/or reference material	**Text Books**: [1] Dennis Roddy, Satellite Communication, 4/e, McGraw Hill [2] Pratt and Bostian, Satellite Communication, 2/e, John Wiley and Sons. [3] Louis J. Ippolito, Jr.Satellite Communications Systems Engineering: Atmospheric Effects, Satellite LinkDesign and System Performance,Second Edition, John Wiley. **Reference Books**: [4] Recommendation ITU-R P.618-11, P Series Radio Wave Propagation. [5] Floyd F. Sabins, Remote Sensing: Principles and Interpretation, 3rd edition (August 1996), W H Freeman & Co. [6] Tri T Ha, Digital Satellite Communication, McGraw Hill

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO# 10**	**PO #11**	**PO# 12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2
CO#4	1	2	2	1	1	2	2	1	2	1	1	1	3	3	2
CO#5	2	3	1	2	1	1	1	2	2	1	1	1	2	1	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE819</td><td>RFIC Design</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods: (Continuous Assessment (CA), Mid-semester assessment (MA) and end assessment (EA))</td></tr>
<tr><td colspan="2">Analog and Digital Communication (ECC401, ECC501), Signals and Systems (ECC303), Analog IC Design (ECE712)</td><td colspan="6">Assignments, Quiz/class test, Mid-semester Examination and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After going through the course, student will be able to
• CO1: Analyze various architectures of today’s digital radio transmitters and receivers.
• CO2: Analyze and design basic RF building-blocks in CMOS technology.
• CO3: Define basic RF measurements parameters such as S-parameters, sensitivity, noise figure, IIP3
• CO4: Assimilate the design techniques VCO, LNA as well as other front-end circuits</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="7">Module-I: Introduction to RF IC Design Concepts [L – 6]
Basic Concepts in RF Design, passive on chip components and layouts, transceiver architectures, circuit analysis techniques at radio frequencies.
Module-II: Semiconductor radio frequency components [L – 8]
RF diodes, MOS transistor, determination of model parameters, parasitics of MOS transistors and high frequency behaviour of basic amplifier.RF Transistor Materials – The Transistor Equivalent Circuit – Y Parameters – S Parameters – Understanding RF Transistor Data Sheets; BSIM3 parameters of NMOS and PMOS transistors, matching and biasing networks for transistors
Module-III: Noise and non-linearity. [L – 4]
Noise Figure and representation of non-linearity, intermodulation products and intercept points
Module-IV: Filter Design [L – 4]
Resonator and filter configurations, realization of filter for specific transfer function, implementation of filters a coupled line filter.
Module V:RF Transistor Amplifier[L – 8]
Stability consideration, constant, gain and noise figure circles. Low Noise Amplifiers: SNR, LNA topologies, power constrained CMOS LNA design, low-current CMOS inverter LNAs, low-voltage LNA topologies, differential LNA design methodology, process variation in tuned LNAs, impact of temperature variation in tuned LNAs, low-noise bias networks for LNAs, MOSFET layout of LNA.
Module-VI: RF Mixers [L – 6]
Basic design concepts, single end diode mixer single balanced and double balanced diode mixer design. Transistor mixers, , conversion loss.
Module-VII: RF Oscillators [L – 6]
Basic Principles, Phase Noise, negative resistance oscillators, transistor oscillators, VCO design methodology, frequency scaling of CMOS VCO, VCO layoutPhase lock loops, frequency synthesizers
Module-VIII:RF power amplifiers [L – 4]
Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations</td></tr>
</table>

Text Books, and/or Reference material	**Text Books:** 1. R Ludwig and P Bretchko, *RF Circuit Design: Theory and Application*, Pearson Education, New Delhi. 2. SorinVoinigescu,*High Frequency Integrated Circuits*, Cambridge UniveityPress,UK, 2013. **Reference Books:** 1. BehzadRazavi, RF Microelectronics Prentice Hall of India, 2001 2. Thomas H. Lee, The Design of CMOS Radio Frequency Integrated Circuits, Cambridge University Press.

COURSE ARTICULATION MATRIX

Mapping of Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO# 10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	2	1	2	2	1	1	1	1	1	1	2	1	1
CO#2	3	2	2	2	2	2	1	1	1	2	1	1	2	1	1
CO#3	3	3	3	1	1	2	1	1	2	2	1	1	3	3	2
CO#4	1	2	2	1	1	2	2	1	2	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE820	Low Power Circuits and Systems	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous Assessment (CA:15%), Mid-Term Assessment (MA:25%) and End-Term Assessment (EA:60%))					
Electronic Devices and Circuits I (ECC302), VLSI Design (ECC602)		Continuous Assessment (CA): Quizzes/Class tests/Assignments/Attendance					
Course Outcomes	• **CO 1: Learn** to design and optimize CMOS logic circuits and extract parasitic elements. • **CO 2: Understand** sources of power dissipation and be able to estimate energy dissipation in typical circuits • **CO 3: Apply** different techniques to minimize dynamic dissipation. • **CO 4: Learn** the different sources of leakage in MOS transistors and how to minimize leakage dissipation at the device level as well as in circuit design.						
Syllabus/ Topics Covered	**Module-I:**(L – 05) **Introduction**: Need for Low power VLSI chips, MOS Transistor structure and device model, The CMOS inverter and other gates; why CMOS for Low Power? CMOS Logic design methodology, Circuit optimization for performance. **Module – II:** (L – 06)						

	CMOS layout and Fabrication: Typical CMOS circuit layout, IC fabrication overview, CMOS process flow, Imperfections in fabrication steps, Design rules and their importance; MOS device details – parasitic elements and their estimation, importance of device scaling. **Module – III:** (L- 06) **Power dissipation mechanisms in CMOS circuits**: Static and Dynamic dissipation, Dynamic power dissipation – switching loss, short circuit dissipation, concept of switching activity; Concept of signal activity, signal probability and activity, Signal activity computation – Boolean difference, estimation of probability and activity in complex logic circuits; **Module – IV**: (L – 08) **Dynamic dissipation management** –Supply voltage scaling approaches**:** Static Voltage Scaling; Single-level Voltage Scaling (SVS), Speed vs dissipation, Speed management approaches, circuit level – Transistor sizing, Architecture level – Parallel and pipeline architectures, Algorithm level transformations; Static Voltage Scaling Design Procedure, Critical path and its management; Multi-level Voltage Scaling (MVS), MVS issues – Layout, Level converters, Power up/down sequencing; Dynamic Voltage Scaling; Dynamic Voltage and Frequency Scaling (DVFS), DVFS architecture. **Module-V:** (L – 06) **Dynamic dissipation management – Switched capacitance minimization approaches**: What is switched capacitor? Switched capacitor minimization techniques – Hardware/Software trade-off, Bus Encoding, Use of Number system, Glitching Power minimization, Architecture Level Optimization, Clock gating, State Encoding of FSM's. **Module-VI:** (L – 06) **MOS Transistor revisited**: Review of quantum theory of solids, concept of quantum mechanical tunneling, Leakage mechanisms in MOS transistor – diode leakage, sub-threshold current, sub-threshold swing; short channel effects – Gate tunneling, reducing gate tunneling – high-k technology, DIBL and GIDL effects; Recent advances in MOS transistor design – SOI technology, FinFET, Gate All Around (GAA) FET. **Module-VII:** (L – 03) **Static Power Optimization Techniques**: Comparison of static and dynamic loss in modern chips; Stand-by and Run-time leakage; Stand-by leakage reduction techniques, Transistor stacking, VT CMOS approach, Power gating, MT CMOS technology, Power gating issues, DVFS with Power gating; Run-time leakage reduction, Dynamic V_{DD} scaling, Dual V_t approach, V_t hopping. **Module-VIII:** (L – 02) **Battery operated system design**: Battery construction and working principle, Battery capacity and energy density, comparison of different storage cell technologies; Battery charging and discharging profiles and their effects on battery capacity and life; Design of multi-battery system installations.
Text Books, and/or reference material	**Text Books:** 1. Ajit Pal,**"***Low Power VLSI Circuits and Systems***"**, Springer, 2015. 2. Kaushik Roy and Sharat C Prasad, **"***Low Power CMOS VLSI circuit Design***"**, John Wiley and Sons, 2000. **Reference Books:** 1. Anantha P Chandrakasan and Robert W Brodersen, **"***Low Power Digital CMOS Design***"**, Kluwer Academic Publishers, Holland, 1995. 2. Gary B Yeap K, **"***Practical Low Power Digital VLSI Design***"**, Kluwer Academic Publishers, 1998. 3. Kuo J B and Lou J H, **"***Low Voltage CMOS VLSI Circuits***"**, John Wiley and Sons, Singapore, 1999.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	3	2	2	1	1	1	1	1	1	2	2	2	1
CO#2	2	3	2	1	1	1	1	1	1	1	2	1	2	2	1
CO#3	3	3	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective(PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE821	Advanced Antenna Synthesis	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Electromagnetic Theory and Transmission Lines (ECC403), Analog Communication (ECC401), Digital Communication (ECC501), Antenna and Wave Propagation (ECC601)		CT+MT+EA					
Course Outcomes	• **CO 1:** Ability to characterize resonance and radiation property of an antenna based on application • **CO 2:** Learn various design parameters that affects an antenna and antenna array patterns. • **CO 3:** Understand different types of antenna based on the radiation mechanism like wire antenna, aperture antennas, traveling wave antenna. • **CO 4:** Understand different types of antenna based on the design mechanism like log periodic antenna, log spiral antenna and electrically long antenna as well as electrically small antenna. • **CO 5:** Analyze and synthesize different types of antennas for different wireless communications.						
Topics Covered	**Module I. Brief review on antenna fundamentals [L – 4]** Antenna fundamentals; Vector potentials and solution of the vector potential wave equation; Antenna theorems and definitions. **Module II. Antenna Array design and characterization [L – 6]** Linear, planar and circular array - theorems and pattern synthesis. **Module III. Integral Equations[L – 4]** Moment method, self and mutual impedances **Module IV. Scanning antennas [L – 8]** Signal processing antennas, travelling wave and broadband antenna; Concept of smart						

	antennas. **Module V. Microstrip antennas [L – 8]** Operating principle, modes, field patterns, impedance, feeding techniques and polarization; Arrays and feed networks. **Module VI.** Aperture antennas **[L – 6]** Huygen's principle, Babinet's principle; Fourier transform theory and its applications; The Geometrical theory of diffraction and uniform theory of diffraction techniques and their applications. **Module VII. Antenna measurements[L – 6]** Antenna ranges, Impedance Measurements, Radiation Patterns, Gain Measurements, Directivity Measurements, Radiation Efficiency, Current Measurements, Polarization Measurements**.**
Text Books, and/or reference material	**Text Books:** [1] C. A. Balanis, *Antenna Theory : Analysis and Design*, 3rd ed., John Wiley & Sons, Hoboken, New Jersey, 2005 [2] John D.Kraus, Ronald J.Marhefka "*Antennas: for all Applications*" 4th ed.,, Tata McGraw- Hill Inc., New Delhi, 2006. **Reference Books:** [1] E C Jordan and K G Balmain, *Electromagnetic Waves & Radiating Systems*, 2nd ed., Pearson, New Delhi, 2015 [2] R. C. Johnson and H. Jasik, "*Antenna Engineering handbook*", 3rd ed., Mc-Graw Hill Inc., New York, 1993. [3] I. J. Bhal and P. Bhartia, "Micro-strip antennas", Artech house, Dedgham, MA, 1980. **Online Reference Material(s):** https://nptel.ac.in/courses/117107035/

COURSE ARTICULATION MATRIX

Mapping CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)

PO/PSO CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12	PSO #1	PSO #2	PSO #3
CO#1	2	1	2	1	1	2	1	1	1	-	-	2	2	2	1
CO#2	3	2	2	1	1	2	1	1	1	-	-	1	2	1	1
CO#3	3	3	1	1	1	-	-	-	-	-	-	1	3	1	1
CO#4	1	2	1	1	1	3	2	1	1	-	1	1	3	1	2
CO#5	2	3	2	2	1	1	1	1	1	-	1	2	2	3	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electronics & Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE822</td><td>DSP Architectures in VLSI</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods:
(Continuous Assessment (CA), Mid-term assessment (MA) and End term assessment (EA))</td></tr>
<tr><td colspan="3">VLSI Design (ECC602),
Digital Signal Processing (ECC603)</td><td colspan="5">CA comprises of : Assignment(s), Quiz(zes) /Class test(s)</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After the completion of the course, the student will be able to:
• CO 1: State VLSI design methodology for signal processing systems.
• CO 2: Describe VLSI algorithms and architectures for DSP.
• CO 3: Implement/Simulate basic architectures for DSP using Matlab/CAD tools.
• CO 4: Analyze DSP architectures and evaluate their performance.
• CO 5: Discuss various issues that need to be addressed when implementing DSP algorithms in real hardware with finite resources such as processing speed, memory, and bit resolution.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I. Introduction to Digital Signal Processing [L – 6]
Review of DSPfundamentals: Discrete Systems: Representation of Systems, Properties of DSP systems, Difference equation and its relationship with system function, Impulse response and frequency response.
Module II. Digital Signal Processing Algorithms [L – 6]
Introduction for DSP algorithms: VLSI Design flow, Mapping algorithms into Architectures: Graphical representation of DSP algorithms – signal flow graph (SFG), data flow graph (DFG), critical path, dependence graph (DG). Data path synthesis, control structures, Optimization at Logic Level and architectural Design, Loop bound and iteration bound, Algorithms for computing iteration bound
Module III. Introduction to DSP systems [L – 5]
DSP Systems, Parallel and pipeline of signal processing application: Architecture for real-time systems, latency and throughput related issues, clocking strategy, power-aware structures, array architectures; Pipelining processing of Digital filter, Parallel processing, Parallel and pipelining for Low power design, Optimization with reference to speed, area and power, asynchronous and low power system design, ASIC (application-specific integrated circuits) and ASISP (application-specific instruction-set processors) design.
Module IV. Systolic Array Architecture [L – 6]
Methodology of systolic array architecture, FIR based Systolic Array, Selectionof Scheduling Vector, Matrix multiplication of systolic array.
Module V. Signal processing Architectures [L – 7]
Convolution technique, Retiming concept, Folding/Unfolding Transformation, Fast convolution, Cook-Toom algorithm, modified Cook-Toom algorithm. CORDIC architecture.
Module VI. Scaling and Round-off noise [L – 5]
Scaling and round-off noise, scaling operation, round-off noise, state variable description of digital filters, scaling and round-off noise computation, round-off noise in pipelined IIR filters.
Module VII. Low Power Design [L – 7]
Theoretical background, Scaling v/s power consumption, power analysis, Power estimation approach, Power reduction techniques.</td></tr>
</table>

Text Books, and/or Reference materials	**Text Book:** Keshab K. Parhi, "*VLSI Digital Signal Processing Systems, Design and Implementation*", Wiley-Interscience, 1999. **Reference Book:** 1. Uwe Meyer-Baese, "*Digital Signal Processing with Field Programmable Gate Arrays*", Springer, Third Edition, 2007. **NPTEL/SWAYAM/Other Video Lectures:** 1. Prof. N. Chandrachoodan, IITM, (2019) *Mapping Signal Processing Architectures in VLSI*

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	2	1	3	3	1	1	1	1	1	1	1	2	2	2	1
CO#2	3	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#3	3	2	3	1	1	1	1	1	1	1	1	1	3	2	2
CO#4	1	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO#5	2	3	2	2	1	2	2	1	1	1	1	1	2	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 43				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE823	Internet of Things Technology	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: Continuous (CT), Mid-Term (MT),End Assessment (EA)					
NIL		CT+MT+EA					
Course Outcomes	**CO1**: Explain the term IoT and understand the main components of IoT systems. **CO2**: Recognize, interpret and apply a variety of enabling technologies, connectivity technologies and communication protocols that occur in IoT systems. **CO3**: Design and analysis of a complete working IoT system involving prototyping, programming and data analytics						
Topics Covered	14. **Introduction to IoT**: Introduction and definition of IoT; -Basics of networking: Network types; Network topologies; OSI model; Adressing TCP/IP; -Predecessors of IoT: WSN; M2M; Cyber Physical Systems **(5L)** 15. **IoT enabling technologies**: Cloud computing; Big data analytics; Embedded systems; -IoT levels: level 1 to level 6 -Introduction to sensors; actuators; microcontrollers, and their interfacing: Sensors-characteristics, types; Sensor interfacing-interfacing gas sensors with nodeMCU/ Arduino, interfacing pH sensor, interfacing pulse sensor. -Actuators: types, functions						

	-Microcontrollers and overview **(8L)** 16. **IoT communication technologies:** -Constrained nodes and networks: types; lossy and low power networks -Protocols for messaging and transport: Messaging protocols- MQTT; CoAp; XMPP; DDS -Protocols for addressing and identification: IPV4; IPV6; Uniform Resource Identifier (URI); 6LoWPAN; Discovery protocols like universal plug and play; multicast DNS. **(6L)** 17. **IoT connectivity technologies:** IEEE 802.15.4; Zigbee; RFID; NFC; Sigfox; LoRa; NB-IoT; WiFi; Bluetooth **(2L)** 18. **Cloud for IoT**: challenges; selection of cloud service provider; introduction to Fog computing- working principle; edge and Fog computing; security aspects. **(2L)** 19. **Data analytics**: Data analysis; Machine learning: supervised and unsupervised; Types of ML models: classification; regression; clustering; Model building process; modeling algorithm; model performance; Big data platform. **(5L)** 20. **IoT case studies and future trends**: Agricultural IoT; Vehicular IoT; Healthcare IoT; Evolution of new IoT paradigms- IoBT; IoV; IoNT; IoD; IoSpace; NFV; SDN; 5G as IoT enabler. **(6L)** 21. **IoT hands on:**-Home automation: smart lighting;Air pollution monitoring;Health care: elderly fall detection; Prevention of drowsiness of drivers by IoT based smart drivers assistance systems. **(9L)**
Text Books, and/or reference material	**Text Books**: 5. Shriram K Vasudevan; Abhishek S Nagarajan; RMD Sundaram, *Internet of Things*, 2nd Edition, Wiley, New Delhi, 2020. 6. S. Mishra, A. Mukherjee, A. Roy, *Introduction to IoT*, 1st Ed., Cambridge University, UK, 2021. **Reference Books**: 7. A. Bahga, V. Madisetti, *Internet of Things: A Hands-on approach,* 1st Ed., Universities Press (India) Pvt. Ltd., Hyderabad, 2014. 8. K. N. Raja Rao (editor), *Internet of Things: Concepts and Applications*, 1st ed., Wiley India, 2021.

COURSE ARTICULATION MATRIX

Mapping of Course Outcome (CO) to Programme Outcome (PO) and Programme Specific Outcome (PSO)															
PO/PSO CO	**PO# 1**	**PO# 2**	**PO# 3**	**PO# 4**	**PO# 5**	**PO# 6**	**PO# 7**	**PO# 8**	**PO# 9**	**PO #10**	**PO #11**	**PO #12**	**PSO# 1**	**PSO# 2**	**PSO# 3**
CO#1	3	3	2	1	1	1	1	1	-	2	-	2	2	2	3
CO#2	3	2	2	2	2	1	1	-	-	1	1	2	3	2	3
CO#3	3	2	3	3	3	2	2	1	-	3	3	2	3	3	3

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<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Elective (PEL)</td><td colspan="4">Total Number of contact hours = 42</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECE824</td><td>VLSI Testing and Verification</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous Assessment (CA:15%), Mid-Term Assessment (MA:25%) and End-Term Assessment (EA:60%))</td></tr>
<tr><td colspan="3">Digital Circuits and Systems (ECC402), VLSI Design (ECC602)</td><td colspan="5">Continuous Assessment (CA): Quizzes/Class tests/Assignments/Attendance</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After successful completion of the course, the student will be able to:
• CO 1: Extend knowledge of the requirement of fault modeling in VLSI circuits.
• CO 2: Generate test vectors to test a circuit efficiently covering maximum faults.
• CO 3: Demonstrate the concept of Memory testing techniques.
• CO 4: Discuss Built-in-Self Test and its application in modern digital design.
• CO 5: Use modern tools for testing and verification.</td></tr>
<tr><td>Syllabus/
Topics Covered</td><td colspan="7">Module I. Introduction [L –4]
Physical faults and their modeling. Fault equivalence and dominance; fault collapsing, Fault simulation: parallel, deductive and concurrent techniques; critical path tracing.
Module II. Test generation for combinational circuits[L – 4]
Boolean difference, D-algorithm, Podem, random, etc. Exhaustive, random, and weighted test pattern generation; aliasing and its effect on fault coverage.
Module III. PLA testing[L – 4]
Cross-point fault model, test generation, easily testable designs.
Module IV. Memory testing [L – 4]
Permanent, intermittent and pattern-sensitive faults; test generation.
Module V. Delay faults and hazards [L – 6]
Test pattern generation techniques, ATPG and its different types.
Module VI. Test pattern generation for sequential circuits[L – 6]
Ad-hoc and structures techniques scan path and LSSD, boundary-scan.
Module VII. Built-in Self-Test techniques[L – 6]
LBIST and MBIST. Verification: logic level (combinational and sequential circuits), RTL-level (data path and control path). Verification of embedded systems. Use of formal techniques: decision diagrams, logic-based approaches.
Module VIII. ASIC/IP Verification[L – 4]
Direct and random testing, Error detection, and correction codes.
Module IX. Post-Silicon Validation [L – 4]
Functional test patterns development and validating, test program and test software to enable functional and tress testing of features, validation with real use case applications: OS boot and stress testing, performance validation with industry-standard benchmarks, characterization of various electrical and thermal parameters as per device specification.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Book:
1. M. L. Bushnell and V. D. Agrawal, “Essentials of Electronic Testing for</td></tr>
</table>

	Digital, Memory and Mixed-Signal VLSI Circuits", Springer, 2nd edition, 2004. **Reference Books:** 1. A. Krstic and K-T Cheng, "*Delay Fault Testing for VLSI Circuits*", Kluwer Academic Publishers, 3rd edition, 2003. 2. N. K. Jha and S. Gupta, "*Testing of Digital Systems*", Cambridge University Press, 2nd Edition, 2003. 3. M. Abramovici, M. A. Breuer and A. D. Friedman, "*Digital Systems Testing and Testable Design*", Wiley-IEEE Press, 3rd Edition, 1994. 4. P. K. Lala, "*Fault Tolerant and Fault Testable*", Prentice-Hall, 4th Edition, 1986.

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	2	2	2	1	1	2	1	1	1	1	1	1	3	2	2
CO#2	2	1	2	2	1	2	1	1	1	1	1	1	2	2	2
CO#3	2	1	2	2	1	2	2	1	1	1	1	1	3	3	2
CO#4	2	1	2	2	1	2	1	1	1	1	1	1	3	3	2
CO#5	2	1	2	2	1	2	1	1	1	1	1	1	3	2	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electronics and Communication Engineering							
Course Code	Title of the course	Program Core (PCR) / Elective (PEL)	Total Number of contact hours = 42				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE825	Statistical Signal Processing	PEL	3	0	0	3	3
Pre-requisites			Continuous Assessments : Class Assessment (CA), Mid-Sem (MA) and End-Sem Assessment (EA)				
Digital Signal Processing (ECC603), Probability Theory for Engineering Application (ECO541) / any other equivalent subject from SWAYAM, NPTEL, etc.			(CA-15) +(MA-25) + (EA-60)				
Course Outcomes	**CO1: Students are able to apply hypothesis testing to signal and detection problems.** **CO2: Students are able to evaluate detector performance.** **CO3: Students can decide and choose among MLE, MAP and MMSE estimators given a parameter estimation task.** **CO4: Students are able to apply and design least squares based adaptive filters for stochastic signals.**						
Topics Covered	**1. Introduction to statistical signal processing (1 hr.)** **2. Module-1 : Introduction to Random Processes (6 hrs.)** Review of probability and random variables, Linear algebra of random variables, Random						

	processes, Linear shift invariant systems with random inputs, White noise and spectral factorization theorem **3. Module-2 :Estimation Theory(8 hrs.)** Linear models of random signals, Estimation theory 1, Estimation theory 2 - MVUE and Cramer Rao lower bound, Cramer Rao lower bound 2, MVUE through sufficient statistics, MVUE through sufficient statistics 2 **4. Module-3 :Methods of Parameter Estimation (4 hrs.)** Method of moments and Maximum likelihood Estimation (MLE), Properties of maximum likelihood estimation, Bayesian estimation, bayesian estimation 2 **5. Module-4 :Wiener Filter (5 hrs.)** Optimal linear filters : Wiener filter, FIR Wiener filter, Noncausal IIR Wiener filter, Causal IIR Wiener filter **6. Module-5 :Linear Prediction of Signals (4 hrs.)** Linear prediction of signals 1, Linear prediction of signals 2, Linear prediction of signals 3 **7. Module-6 :Adaptive Filter (4 hrs.)** Adaptive filters 1, Adaptive filters 2, Adaptive filters 3, Adaptive filters 4 **8. Module-7 :Recursive Least Squares (RLS) Adaptive Filter (4 hrs.)** Recursive least squares (RLS) adaptive filter, Recursive least squares (RLS) adaptive filter-2 **9. Module-8 :Kalman Filter (4 hrs.)** Kalman filter-1, Vector Kalman filter **10. Module-9 : Introduction to Applications of SSP (2 hrs.)** Common applications of SSP in communications, medical diagnosis, radar signal processing/climate modelling, pattern recognition, speech and audio processing, image and video processing, and geophysical signal processing
Text Books, and/or Reference Materials	**Text Books**: 1. M. H. Hayes, "Statistical Digital Signal Processing and Modeling " , 2002, John Willey 2. S. M. Kay "Fundamentals of Statistical Signal Processing : Estimation Theory", 1993, Prentice Hall 3. D. G. Manolakis, V. K. Ingle, and S. M. Kogon, "Statistical and Adaptive Signal Processing" 2000, McGraw Hill

COURSE ARTICULATION MATRIX

Mapping of CO (Course Outcome) to PO (Programme Outcome) and PSO (Programme Specific Outcome)															
PO/PSO CO	**PO #1**	**PO #2**	**PO #3**	**PO #4**	**PO #5**	**PO #6**	**PO #7**	**PO #8**	**PO #9**	**PO #10**	**PO #11**	**PO #12**	**PSO #1**	**PSO #2**	**PSO #3**
CO#1	3	1	2	1	3	3	3	1	2	2	1	2	3	3	2
CO#2	3	3	1	2	3	1	3	1	3	2	1	2	3	2	3
CO#3	3	3	1	3	3	2	2	1	3	2	1	2	3	2	2
CO#4	3	3	2	3	3	2	2	1	3	2	1	2	3	3	2

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