NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

B. Tech in Electronics & Communication Engineering

CONTENTS

MISSION AND VISION

Mission

- To advance and cater knowledge in the areas of Communication, Signal Processing and VLSI.
- To teach state of the art technologies to meet the growing challenges.
- To carry research in frontier areas.

Vision

- To produce highly competent and resourceful young engineers who can perform well in varied professions.
- To develop a strong fundamental base which enables students to explore academic and collaborative interactions with industry, academia and research organizations.
- To develop excellent research facilities.

LIST OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEOs	DESCRIPTION
PEO#1	**Knowledge of Basic Science and Engineering** To nurture ECE undergraduates with a strong foundation in mathematics, science and basic engineering that will usher them towards innovation in areas such as Semiconductors, VLSI, Analog and Digital Integrated Circuits and Systems, Wireless Communications, Signal Processing, Antenna Engineering as well as Microwave Engineering.
PEO#2	**Engineering Design and Experimental Skills** To train the students with practical engineering problem-solving skills in order to provide them with the platform where their contributions will be relevant to the general practice of Electronics and Communication system design and measurement. In conjunction with this, the students will have exposure to the regulatory ruling that governs the design principles and specifications.
PEO#3	**Fostering Interest in Higher Education** To encourage engineering graduates, with appropriate course modules, in preparing for competitive examinations that will help them to pursue higher studies including research in relevant disciplines.
PEO#4	**Technical Knowledge** To foster the understanding of the students based on the fundamentals with a flavour of advanced technical insights that will usher the students to face challenges to tackle complex electronics engineering problems.
PEO#5	**Incubating Professional and Ethical Attitude** To nurture professional and ethical attitude, communication skills as well as develop the ability to contribute in a group. Develop an ambience where the student can correlate technological aspects to social relevance with strong insight to contribute to the needs of industry, National research establishments and academia.

List of Programme Outcomes (POs)

POs	DESCRIPTION
PO#1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO#2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO#3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO#4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO#5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO#6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO#7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO#8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO#9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO#10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO#11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO#12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

LIST OF PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSOs	DESCRIPTION
PSO#1	**Analyze** Apply the acquired knowledge to understand the scientific, engineering and financial aspects of ECE related engineering problems.
PSO#2	**Design** Provide hardware and software solutions to ECE related engineering problems using modern tools.
PSO#3	**Improve** Work for improvement of living experience of individuals but at the same time being responsible to society and environment.

CURRICULUM and SYLLABI of B.Tech in ECE

(2018-19 onwards)

Semester I

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	MAC01	Mathematics-1	3-1-0	4
2	PHC01	Physics	2-1-0	3
3	CYC01	Engineering Chemistry	2-1-0	3
4	XEC01	Engineering Mechanics	2-1-0	3
5	ESC01	Environmental Science	2-0-0	2
6	XES51	Engineering Graphics	1-0-3	2.5
7	HSS51	Professional Communication Lab	1-0-2	2
8	PHS51	Physics Laboratory	0-0-2	1
9	CYS51	Chemistry Laboratory	0-0-2	1
10	WSS51	Workshop Practice	0-0-3	1.5
11	XXS51	Co-Curricular Activities	0-0-2	1
		Total:	**13-4-14**	**24**

<table>
<tr><th>Course code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>MAC01</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic concepts of function, limit, differentiation and integration</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Fundamentals of Differential Calculus
• CO2: Fundamentals of Integral Calculus
• CO3: Fundamentals of Vector Calculus
• CO4: Basic Concepts of Convergence</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested Text Books
1. E. Kreyszig, Advanced Engineering Mathematics: 10 th edition, Wiley India Edition.
2. Daniel A. Murray, Differential and Integral Calculus, Fb & c Limited, 2018.
3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2013.
Suggested Reference Books
1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011.
2. Thomas and Finny: Calculus and Analytic Geometry, 11 th Edition, Addison Wesley.</td></tr>
</table>

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 and End Term Assessment (EA))					
NIL		CT+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	**Suggested Text Books** 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **Suggested Reference Books** 1. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 2. Fundamental of Optics, Jankins and White, McGraw-Hill 3. Optics, A. K. Ghatak, Tata McGraw-Hill 4. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 5. Lasers and Non-linear Optics, B. B. Laud , New Age International Pvt Lt

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) and end assessment (EA))
None	CT+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

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th><th></th></tr>
<tr><td>XEC01</td><td>Engineering Mechanics</td><td>PCR</td><td>2</td><td>1</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">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</td></tr>
</table>

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>ESC01</td><td>Environmental Science</td><td>PCR</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">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.</td></tr>
</table>

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. 1^{st}, 2^{nd}, 3^{rd} and 4^{th} 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 Books, 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						

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>HSS51</td><td>Professional Communication Lab</td><td>PCR</td><td>1</td><td>0</td><td>2</td><td>3</td><td>2</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous Test (CT) and/or End Assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td colspan="6">CT</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Improvement in linguistic proficiency of the learners
• CO2: Improvement in communicative ability of the learners</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested Text Book
1. English for Engineers –Sudharshana & Savitha (Cambridge UP)

Suggested Reference Books
1. Technical Communication—Raman & Sharma (Oxford UP)
2. Effective Technical Communication—M A Rizvi (McGraw Hill Education)</td></tr>
</table>

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>PHS51</td><td>Physics Laboratory</td><td>PCR</td><td>0</td><td>0</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested Books
1) A Text Book on Practical Physics – K. G. Majumdar.
2) Practical Physics – Worsnop and Flint
Reference
1) Instruction sheets</td></tr>
</table>

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 weak acids by pH meter. ii. Experiments based on conductivity measurement: Determination of amount 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 titratio v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, cis-bis(glycinato)copper(II) monohydrate and their characterizati 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 present in a supplied solution. ix. Chromatography: Separation of two amino acids by paper chromatography x. Determination of saponification value of fat/ vegetable oil
Text Books, and/or reference material	**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

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>WSS51</td><td>Workshop Practice</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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.</td></tr>
</table>

	• 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

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><th rowspan="2">Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th></tr>
<tr><td>XXS51</td><td>Co-curricular Activities</td><td>PCR</td><td>0</td><td>0</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">Course assessment methods: Continuous evaluation (CE) and end assessment (EA)</td></tr>
<tr><td>NIL</td><td colspan="7">CE + EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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</td></tr>
<tr><td>Topics Covered</td><td colspan="7">YOGA
• Introduction of Yoga.
• Sitting Posture/Asanas- Padmasana, Vajrasana, Ardha kurmasana, Ustrasana, Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar.
• Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra.
• Laying Posture/Asanas- Pavana Muktasana, Uttana Padasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani.
• Meditation- Yog nidra, Om chant, Pray chant.
• Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardha chandrasana, Trikonasana, Utkatasana, Padahastasana.
• Pranayama- Deep breathing, Anulom Vilom, Suryabhedi, Chandrabhedi.
• Kriya- Kapalbhati, Trataka.
ATHLETICS
• Introduction of Athletic.
• Starting Technique for Track events- Standing start, Crouch start & 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, Over head 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.</td></tr>
</table>

	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), Abdal chagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus. • Unnat Bharat Abhiyaan • Matribhasha Saptah celebration

Semester II

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	MAC02	Mathematics-II	3-1-0	4
2	CSC01	Introduction to Computing	2-1-0	3
3	ECC01	Basic Electronics	2-1-0	3
4	EEC01	Electrical Technology	2-1-0	3
5	BTC01	Life Science	2-0-0	2
6	XES52	Graphical Analysis using CAD	0-0-2	1
7	CSS51	Computing Laboratory	0-0-2	1
8	ECS51	Basic Electronics Lab	0-0-2	1
9	EES51	Electrical Technology Lab	0-0-2	1
10	XXS52	Co-Curricular Activities	0-0-2	1
		Total:	**11-4-10**	**20**

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>MAC02</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="2">Pre-requisites</td><td colspan="6">Good knowledge on MAC01, Basic concepts of set theory, differential equations and probability.</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: Apply the concepts of differential equations for solving engineering problems.
• CO3: Able to formulate engineering problems of different disciplines using the concepts of Laplace transformation & Fourier transformation.
• CO4: Able to solve problems related to 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 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, Stochastic simulation, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested Text Books
1. E. Kreyszig, Advanced Engineering Mathematics: 9th edition, Wiley India Edition.
2. Gilbert Strang, Linear algebra and its applications (4th Ed.), Thomson (2006).
3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Edition.
Suggested Reference Books
1. S. Kumaresan, Linear algebra - A Geometric approach, PHI (2000).
2. C. Grinstead, J. L. Snell, Introduction to Probability, American Math. Society</td></tr>
</table>

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>CSC01</td><td>Introduction To Computing</td><td>PCR</td><td>2</td><td>1</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic knowledge of computer</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested 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
Suggested 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</td></tr>
</table>

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>ECC01</td><td>Basic Electronics</td><td>PCR</td><td>2</td><td>1</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">(10+2) level mathematics and physics</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Semiconductors (03 hours)
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
2. Diodes (02 hours)
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
3. Diode Circuits (03 hours)
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 Zener diode : Avalanche breakdown and Zener breakdown and characteristics.
3.2.2 Zener diode as a voltage regulator
3.2.3 Display devices : LED and LCD
4. Bipolar Junction Transistor (04 hours)
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</td></tr>
</table>

	5. **Transistor Biasing** (02 hours) 5.1 Need of biasing 5.2 Methods of biasing : base resistor or fixed bias, emitter feedback, voltage dividerbiasing 5.3 Stability of Q-point (qualitative discussions) 5.4 (Numerical problems) 6. **Single Stage Amplifier** (02 hours) 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) 7. **Feedback Amplifier** (03 hours) 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. 8. **Other Semiconductor Devices** (02 hours) 8.1 JFET : Construction, principle of operation, characteristics 8.2 MOSFET: Construction, principle of operation, characteristics 8.3 Power Electronic Device-SCR : Brief discussions 9. **Operational Amplifier** (04 hours) 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 andinverting amplifier. 9.4 Applications: voltage follower, summer, differentiator, integrator, and comparator 10. **Oscillator** (02 hours) 10.1 Positive feedback and condition of oscillation 10.2 R-C phase-shift oscillator, Wien bridge oscillator 11. **Boolean Algebra** (01 hour) 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 their Applications 12. **Logic Gates** (01 hour) 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 13. **CRO and its applications and other test and measurement instruments** (01 hour)
Text Books, and/or reference material	**Suggested Text Books** 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad&Nashelsky 2. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates, 7/e. **Suggested 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.

<table>
<tr><th>Course Code</th><th>Title of the course</th><th>Program Core (PCR) / Electives (PEL)</th><th colspan="4">Total Number of contact hours</th><th>Credit</th></tr>
<tr><th></th><th></th><th></th><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)</th><th>Total Hours</th><th></th></tr>
<tr><td>EEC01</td><td>Electrical Technology</td><td>PCR</td><td>2</td><td>1</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: To learn the fundamentals of Electric Circuits and Network theorems.
• CO2: To develop an idea on Magnetic circuits, Electromagnetism
• CO3: To learn about single phase and polyphase AC circuits.
• CO4: Introduction to single phase transformer.
• CO5: Introduction to the transient analysis of RLC circuits with DC excitation.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Fundamentals of Electric Circuits: Ohm’s laws, Kirchhoff’s laws, Independent and Dependent sources, Analysis of simple circuits. (3)
Network theorems. (4)
Magnetic field, Concept of magnetic circuits, Magnetomotive Force, Reluctance, Ampere’s circuital law and Biot-Savart law, Determination of B/H curve, Comparison of electric and magnetic circuit, Electromagnetic induction, Faraday’s laws of electromagnetic induction, Direction and Magnitude of induced E.M.F. (7)
Self and mutual Inductance, Inductances in series and parallel, Energy stored in inductor, Capacitance, Capacitance in series and parallel, Relationship between charge, voltage and current, Energy stored in capacitor (5)
Transients with D.C. excitation. (5)
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, Behaviour of A.C. circuits, Resonance in series and parallel R-L-C circuits (7)
Single-Phase Transformer , equivalent circuits, open circuit and short circuit tests (6)
Polyphase 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>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested Text Books
1. Electrical & Electronic Technology by Hughes, Pearson Education India
Suggested Reference Books
1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd
2. Electrical Engineering fundamentals by V. Deltoro, Pearson Education India</td></tr>
</table>

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) and end assessment (EA))					
None		CT+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
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.

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))
None	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 Books, and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 3)… Practical Geometry and Engineering Graphics – W Abbott

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	**Suggested 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 **Suggested 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						

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	
ECS51	**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	**Suggested Text Books** 1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul Malvino Dr., David J. Bates, et al. **Suggested Reference Books** 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates

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))					
NIL		CT+EA					
Course Outcomes	• CO1: Understand the principle of superposition and three phase connections • CO2: Understand the principle of maximum power transfer • CO3: Understand the characteristics of CFL, incandescent & carbon Lamp • CO4: Understand the calibration of energy meter. • CO5: Understand open and short circuit test of single phase transformer. • CO6: Analyse RLC series and parallel circuits						
Topics Covered	1.To verify Superposition and Thevenin 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						
Text Books, and/or reference material	**Suggested Text Book** Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru (Author), J M Chuma (Author), H U Ezea (Author)						

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	
XXS52	**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, Ardha Matsyendrasana (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), Ardha Halasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, Supta Vajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini Or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- Ardha Chakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), Parshwa Konasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadi sodha, 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

COURSE ARTICULATION MATRIX for 1st Year Subjects

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC01	CO1	3	3	1	2	-	-	-	-	1	-	-	-
	CO2	3	3	1	2	-	-	-	-	1	-	-	-
	CO3	3	3	1	2	-	-	-	-	1	-	1	1
	CO4	3	-	-	2	-	2	-	-	1	-	-	-
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
CYC01	CO1	1	2	-	-	-	-	-	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	1	2	1	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	-	2	-	1	-	-	-	-	-
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
ESC01	CO1	3	-	-	-	-	-	2	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	2	-	-	-	-	-	2	-	-	-	-	-
	CO4	1	-	3	-	-	2	1	-	-	-	-	-
XES51	CO1	1	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	1	-	-	-	-	-	-	-	-	-	-
	CO3	1	-	1	-	-	-	-	-	-	-	-	-
HSS51	CO1	-	-	-	-	-	1	-	-	1	3	-	3
	CO2	-	-	-	-	-	2	-	-	2	3	-	3
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
CYS51	CO1	2	1	-	1	-	-	-	-	-	-	-	-
	CO2	-	1	-	1	1	2	-	-	-	-	-	-
	CO3	2	-	-	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	1	1	-	-	-	-	-	-	-
WSS51	CO1	2	-	-	-	-	1	-	-	-	1	-	-
	CO2	1	-	1	-	-	1	-	-	-	1	-	-
	CO3	1	-	2	-	-	1	-	-	-	1	-	-
	CO4	1	-	-	-	-	2	-	-	-	1	-	-
MAC02	CO1	2	3	1	3	-	-	-	-	2	-	-	-
	CO2	2	3	1	2	-	-	-	-	2	-	-	-
	CO3	2	2	2	3	2	-	-	-	3	-	1	1
	CO4	2	3	2	3	2	1	1	-	2	-	-	-
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	-	-	-	-	-	-	-
ECC01	CO1	2	3	2	2	-	1	-	-	-	-	-	1
	CO2	3	2	1	2	2	1	-	-	2	-	-	1
	CO3	3	2	2	2	3	-	-	-	2	-	-	1
	CO4	3	3	2	2	-	-	-	-	2	-	-	1
EEC01	CO1	3	1	-	-	2	-	-	-	-	1	-	-
	CO2	2	3	2	-	2	-	-	-	-	-	-	-
	CO3	2	3	1	-	-	-	-	-	-	1	-	-
	CO4	3	1	2	-	1	-	-	-	-	-	-	-
	CO5	3	1	2	-	1	-	-	-	-	-	-	-
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	-	-	-	-	-
XES52	CO1	2	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	2	-	-	-	-	-	-	-	-	-	-
	CO3	2	1	-	-	-	-	-	-	-	-	-	-
	CO4	2	1	-	-	-	-	-	-	-	-	-	-
	CO5	1	-	-	-	2	-	-	-	-	-	-	-
CSS51	CO1	3	-	1	-	-	-	-	-	-	-	-	-
	CO2	-	2	1	3	-	-	-	-	-	-	-	-
	CO3	-	1	-	2	1	-	-	-	-	-	-	-
	CO4	-	-	3	2	-	-	1	-	-	-	2	-
ECS51	CO1	3	2	1	2	2	1	-	-	2	-	-	-
	CO2	3	2	2	2	3	-	-	-	2	-	-	-
	CO3	3	3	2	2	-	-	-	-	2	-	-	-
EES51	CO1	3	-	2	-	3	-	-	-	1	-	-	-
	CO2	3	-	2	-	3	-	-	-	1	-	-	-
	CO3	2	3	2	2	1	-	2	-	1	-	-	-
	CO4	2	3	1	2	2	-	1	-	1	1	-	-
	CO5	2	3	1	2	2	-	-	-	1	-	-	-
	CO6	2	3	2	2	2	-	-	-	1	-	-	-
XXS51	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-
XXS52	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

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

Semester III

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	MAC331	Mathematics III	3-1-0	4
2	ECC301	Network Analysis and Synthesis	3-1-0	4
3	ECC302	Electronic Devices and Circuits I	3-1-0	4
4	ECC303	Signals and Systems	3-0-0	3
5	PHC331	Physics of Semiconductor Devices	3-0-0	3
6	PHS381	Semiconductor Devices laboratory	0-0-3	1.5
7	ECS351	Network Analysis and Synthesis Laboratory	0-0-3	1.5
8	ECS352	Electronic Devices and Circuits Laboratory	0-0-3	1.5
9	XXS381	Co-curricular Activities III (Optional)	0-0-0	0
		Total:	**15-3-9**	**22.5**

<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) / 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">Basic knowledge of topics included in MAC01 & MAC02</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"><u>Partial Differential Equations (PDE):</u> 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 (L+T)]
<u>Numerical Methods:</u> 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 Euler's methods for solving first order differential equations. [14(L+T)]

<u>Complex Analysis:</u> Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation 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(L+T)]

<u>Optimization:</u>
Mathematical Preliminaries: Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra.
[2(L+T)]
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(L+T)]</td></tr>
</table>

Text Books, and/or reference material	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 REFERENCE BOOKS 1. Complex Analysis-L. V. Ahfors 2. Elements of partial differential equations- I. N. Sneddon 3. Operations Research- H. A. Taha

COURSE ARTICULATION MATRIX

CO Vs. PO	**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	3	2	1
CO #2	3	3	3	3	2	-	1	-	-	-	-	1	3	2	1
CO #3	3	2	2	3	2	1	1	-	-	-	-	1	3	2	1
CO #4	3	2	3	3	3	1	1	-	-	-	-	1	3	2	1
Avg	3	2.5	2.5	3	2.25	1	1	-	-	-	-	1	3	2	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) / 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>ECC 301</td><td>Network Analysis and Synthesis</td><td>PCR (Program Core)</td><td>3</td><td>1</td><td>0</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Modern Physics, Higher Engg. Mathematics</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Objective</td><td colspan="7">The course teaches fundamentals of network analysis and synthesis such as Laplace transform and its applications in D.C and A.C circuit analysis, characterization of two port networks, representation of two port networks in terms of T and Π networks. It also teaches determination of Z, Y, ABCD and h parameters from two port networks, bisection theorem and its applications, design of attenuators, filters, synthesis of LC, RC and RL driving point admittance functions using Foster and Cauer first and second forms.</td></tr>
<tr><td>Course Outcomes

After going through the course, student will be able to</td><td colspan="7">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.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="7">Unit I:Network Functions and Transient analysis (L=09 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.</td></tr>
</table>

	Unit II: Two Port Networks (L=09 hrs.) 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),** 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=04 hrs.),** Image and scattering parameters, insertion loss. Various types of attenuators (Lattice, T, Π etc. networks). **Unit V: Filters (L=07 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.)** 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 Cauer first 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" Dhanpat Rai& Co.

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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)

<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) / 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>ECC 302</td><td>Electronic Devices and Circuits-I</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) and end assessment (EA)):</td></tr>
<tr><td colspan="3">• General course in Physics
• Basic electrical engineering
• Basic electronics</td><td colspan="5">Assignments, Mid Semester and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. P-N Junction Diode:(4L)
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: (3L)
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)
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)
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:(6L)
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:(6L)
The Junction Field Effect Transistor (Construction, principle of operation, symbol) – Pinch-off Voltage - Volt-Ampere characteristics, The JFET Small Signal Model, MOSFET</td></tr>
</table>

	(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: (4L)** Introduction; Amplifier frequency response, Gain Bandwidth product, Need for multi-stage amplification; R-C coupled amplifiers, Cascode configuration **8. Operational Amplifiers: (6L)** 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) 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	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)

<table>
<tr><th colspan="8">Department of Electronics and Communication Engineering</th></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>ECC 303</td><td>Signals and Systems</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Differential and Integral Calculus</td><td colspan="6">Class Assignments, Mid and End term examinations</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="6">• 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.</td></tr>
<tr><td colspan="2">Topics Covered mapped to Course Outcomes</td><td colspan="4"><u>Topic Details</u></td><td><u>(No. of classes)</u></td><td><u>Course Outcomes (COs)</u></td></tr>
<tr><td colspan="2"></td><td colspan="4">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.</td><td>2</td><td>CO#1, CO#4</td></tr>
<tr><td colspan="2"></td><td colspan="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.</td><td>5</td><td>CO#2, CO#4</td></tr>
<tr><td colspan="2"></td><td colspan="4">Analyzing LTI systems through discrete time difference equation and continuous time differential equation models, natural response, forced response, transient response and stability.</td><td>3</td><td>CO#2, CO#4</td></tr>
<tr><td colspan="2"></td><td colspan="4">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.</td><td>8</td><td>CO#3</td></tr>
<tr><td colspan="2"></td><td colspan="4">Relationship between the various Fourier representations, applications of Fourier representation to mixed signal classes, analyzing sampling of signals through Fourier transforms.</td><td>4</td><td>CO#2,CO #3, CO#5</td></tr>
<tr><td colspan="2"></td><td colspan="4">Discrete Fourier transform, properties of DFT, circular convolution, computations for evaluating the DFT, decimation in time and decimation in frequency FFT algorithms.</td><td>3</td><td>CO#2, CO#3, CO#5 (Self-Learning</td></tr>
</table>

			Module)
	Other essential transforms: Hilbert transforms, properties of Hilbert transforms, representation of complex envelope and bandpass signals. Haar transform, wavelet functions, continuous and discrete wavelet transforms, non-adaptive and adaptive transform coding, wavelet coding.	5	CO#2, 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.	4	CO#3, CO#4
	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.	4	CO#3, CO#4
	Application to linear feedback systems, sensitivity and distortion analysis, stability problem, Routh-Hurwitz criterion, Nyquist stability criterion, sampled data feedback systems.	4	CO#2, CO#4 (**Self-Learning Module**)
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 -- Stéphane Mallat.		

COURSE ARTICULATION MATRIX

Relating the **Course Outcomes** (COs) to the **Program Outcomes** (POs) & **Program Specific Outcomes** (PSOs):

	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)

<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) / Electives (PCR)</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>PHC331</td><td>Physics of Semiconductor Devices</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) and Midterm (MT) end assessment (EA)):</td></tr>
<tr><td colspan="2">PHC 01 in 1st year.</td><td colspan="5">CT, MT, EA Examination</td></tr>
<tr><td>Course Objectives</td><td colspan="6">• To introduce students with the different properties of semiconductor materials.
• To understand the construction and working principal of electronic devises.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">At the end of the course, a student will be able to:
CO # 1. Describe the different electronic properties of semiconductor materials.
CO # 2. Understand the working principal of electronic devises (PN Diode, Photodetector, Solarcell, Light-EmittingDiodes, Laser Diodes, JFET, MOSFET, Tunnel Diode, Gunn Diode, IMPATT Diode, TRAPATT Diodeand semiconductor memory).
CO # 3. Apply the knowledge of memory expansion to design required expandad memory for specific application.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Module – I: (L – 10)
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 heterostructure 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..[CO#1]; [T1, T2, R1]

Module – II: (L –8)
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. [CO# 2]; [T1, T2, R1]

Module – III: (L – 6)
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,Tunnel Diode.. [CO# 2];[T3, R2]

Module – IV: (L – 6)
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.. [CO# 2]; [T1, R3]</td></tr>
</table>

	Module – V: (L – 6) **Semiconductor Memory Device:** Semiconductormemoryorganization,RandomAccessMemory(RAM)(staticanddynamic),CMOS memory circuits, Charge Coupled Devices(CCD).[CO# 3];[T1, R3]
Text Books, and/or reference material	TEXT BOOKS [T1]. Physics of Semiconductor Devices, SMSZE. [T2]. Solid State Electronic Devices, Ben G Streetman & Banerjee [T3]. Microwave Solid-State Devices, S Y Liao REFERENCES [R1]. Semiconductor Physics and Devices, Donald A.Neamen. [R2]. Microwave Engineering, David M. Pozar. [R3]. Integrated Electronics, Millman-Halkias.

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	3	1	2	1	1	2	1	1	-	1	-	1	-	-	1
CO#2	3	2	2	2	2	1	1	1	-	1	1	1	1	1	1
CO#3	3	3	3	2	2	2	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 Physics							
Course Code	Title of the course	Program Core (PCR) / Electives (PCR)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHS381	Semiconductor Device Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods: Continuous (CT) and end assessment (EA)					
PHS 01 in 1st year.		CT, EA Examination					

Course Objectives	• To measure different characteristic parameter of semiconductor materials and devices.
Course Outcomes	At the end of the course, a student will be able to: CO # 1. **Calculate** different characteristic parameter of semiconductor materials. CO # 2. **Measure** and **understand** different characteristic of semiconductor devices. CO # 3. Understand the motion of electrons in free space. CO # 4. Learn the basics of thermal design.
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 [T1]. An advanced course in practical physics,Chattapadhyay and Rakshit. [T2]. Advanced practical Physics, K. G. Mazumdar.

COURSE ARTICULATION MATRIX

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	3	1	2	1	1	2	1	1	-	1	-	1	-	-	1
CO#2	3	2	2	2	2	1	1	1	-	1	1	1	1	1	1
CO#3	3	3	3	2	2	2	1	1	1	1	1	1	2	2	1
CO#4	1	1	2	1	3	-	-	-	-	1	1	2	1	1	3

<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) / 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>ECS351</td><td>Network Analysis & Synthesis 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 (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic knowledge of Electrical Circuits/Network theorems</td><td colspan="4">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">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.</td></tr>
<tr><td>Laboratory experiments covered</td><td colspan="6">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.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">1. Teri L. Piatt (Author), Kyle E. Laferty, “Circuit Analysis Laboratory Workbook (Synthesis Lectures on Electrical Engineering) Lab Manual, Workbook Edition” Morgan & Claypool.
2. Laboratory Instruction Manual.

<u>Reference Books/materials</u>:

1. B. C. Kuo, “Network Analysis and Synthesis”, John Wiley
2. E. Van Valkenburg, “An Introduction to Modern Network Synthesis”, Wiley Eastern Ltd.</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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)

<table>
<tr><td colspan="8">Department of Electronics and Communication Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</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>ECS352</td><td>Electronics Devices and Circuits Lab</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment Methods (Continuous (CT) and end Assessment (EA))</td></tr>
<tr><td colspan="2">Basic Electronic Engineering</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>List of Experiments</td><td colspan="7">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 andplotthefrequency response of Common SourceJFET amplifierandobtainthe bandwidth.
4. Design andtest a 1 kHzrelaxationoscillatorusing UJT
5. Linear ApplicationofOp-Amp (Inverting amplifier, Non-invertingamplifier).
6. IntegratorandDifferentiatorusing IC 741 Op-Amp
7. Adder and Subtractorusing OP-AMP.
8. Mono stable Multivibrator using IC 555
9. Astable Multivibrator using IC 555
10. Schmitt Trigger Circuit- using IC 741
11. IC 565- PLL Applications
12. Voltage Regulator using IC 723,
13. RC phase shift & Wien Bridge oscillator using IC 741</td></tr>
<tr><td></td><td colspan="7">Text Books
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</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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)

Semester IV

Sl. No.	Subject Code	Name of the Subject	L T P	CP
1	ECC401	Analog Communication	3-1-0	4
2	ECC402	Digital Circuits and Systems	3-1-0	4
3	ECC403	Electromagnetic Theory and Transmission Lines	3-1-0	4
4	EEC431	Control Systems	3-0-0	3
5	YYO44*	Open Elective I	3-0-0	3
6	ECS451	Analog Communication Laboratory	0-0-3	1.5
7	ECS452	Digital Circuits and Systems Laboratory	0-0-3	1.5
8	EES481	Control Systems Laboratory	0-0-3	1.5
9	XXS481	Co-curricular Activities IV (Optional)	0-0-0	0
		Total:	**15-3-9**	**22.5**

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	
ECC401	Analog Communication	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Network Analysis & Synthesis (ECC 301), Signal & Systems (ECC 303)		CT+EA					

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 [**8(L+T)**] 2. Amplitude Modulation and Demodulation: DSB, SSB, VSB. Spectra, Circuits and Systems. [**9(L+T)]** 3. Frequency Modulation and Demodulation: Spectra, Circuits and Systems. [**8(L+T)**] 4. Pulse Modulation: Sampling theorem and its proof. PAM, PWM, PPM [**4(L+T)]** 5. Probability, Random Variable & Random Processes: Mean, Moments, ACF, PSD and WSS, Ergodic and other random processes. [**8(L+T)]** 6. Noise. Noise Figure, Noise Temperature, Performance of Analog communication systems in the presence of Noise. [**8(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

Relating the **Course Outcomes** (COs) to the **Program Outcomes** (POs) &**Program Specific Outcomes** (PSOs):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	1	2	1	1	2	1	2	-	-	-	2	2	2	3
2	2	2	3	3	2	-	-	-	-	-	-	2	3	2	2
3	1	1	3	1	2	1	-	-	-	-	-	2	2	2	2
4	3	3	2	2	2	-	-	-	-	-	-	2	3	3	3
5	3	3	3	2	3	-	-	-	-	-	-	3	3	3	2
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><th colspan="8">Department of Electronics and Communication Engineering</th></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>ECC 402</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) and end assessment (EA)):</td></tr>
<tr><td colspan="3">• Electronic Devices and Circuits I
• Basic Electronics</td><td colspan="5">Assignments, Mid Semester and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO # 1. Understand rules of Boolean Algebra and use it for logic synthesis.
CO # 2. Design logic circuits using switches, transistors and integrated circuit building blocks.
CO # 3. Understand binary number system and design corresponding arithmetic circuits.
CO # 4. Explain and implement A/D and D/A converters.
CO # 5. Learn sequential circuit building blocks and implement Finite State Machines.
CO # 6. Understand principles of Error Detection and Correction codes.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1.Introduction: Definition of Analog & Digital information. Characteristics of Digital Circuits. Advantages of Digital systems. (1L)
2.Boolean Algebra: Introduction – rules of Boolean Algebra, axioms, D´Morgan’s theorems (2L)
3.Logic Gates: Basic Gates, Universal Gates, Realization of logic gates using switches, Transistors (MOS and BJT) as switch. (3L)

4.Logic Synthesis: Two level synthesis, SOP/POS forms, canonical forms; Minimization of logical function by - i) Algebraic method, ii)Karnaugh Map method and iii) Quine Mccluskey Method. (3L+1T)

5.Combinational Circuits: Multiplexer, Demultiplexer, Decoder, Encoder, decoder driver, designing using these combinational circuits and their applications. (1L + 2T)

6.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. (3L + 2T)

7.Sequential Circuits: Definition, Elements of sequential circuits - Latches and Registers, 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. (5L + 3T)

8.Multivibrator: Definition of different types of Multivibrators, their realization by logic gates, op-amp and transistors. 555 Timer IC. (3L)

9.A/D & D/A Converter: Different types of D/A & A/D Converters. (4L)

10.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. (4L + 1T)

11.Different logic families such as RTL, DCTL, DTL, HTL, TTL, ECL, MOS & CMOS logic family their importance and applications. (1L + 1T)</td></tr>
</table>

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. REFERENCES: 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) 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	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) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC 403	Electromagnetic Theory and Transmission Lines	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA)):
• Course in mathematics covering vectors, vector calculus • General course in Physics	Assignments, Mid Semester and End Semester Examination

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.

Modules	**Topics Covered**	**Lecture Hours**
1	Historical foundations that led to Maxwell's electromagnetic theory	2
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.	10
3	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	6
4	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.	6
5	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.	6

6	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.	10

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) 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	2	1	2	-	1	1	-	-	-	3	2	1	1
CO#2	3	2	2	2	2	1	-	-	-	-	-	1	2	1	1
CO#3	3	3	3	1	1	-	-	-	-	-	-	1	3	3	2
CO#4	1	2	1	1	1	1	2	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)

<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) / 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>EEC431</td><td>Control System Engineering</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) and end assessment (EA))</td></tr>
<tr><td colspan="3">1. Engineering Physics
2. Signals and Systems</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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]
Modelling of electrical networks, Modelling 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.</td></tr>
</table>

	Root Locus Technique: [4L] The root locus concept, construction of Root Loci, Important properties parameters design by Root 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

	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

<table>
<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>ECS451</td><td>Analog Communication 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">Network Analysis & Synthesis (ECC 301)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Labs Conducted.</td><td colspan="7">1. To generate amplitude modulated wave and determine the percentage modulation.
2. To demodulate the modulated wave using envelope detector.
3. To observe the output waveform of each block of super heterodyne receiver.
4. To measure modulation index in FM and show the demodulated waveform.
5. To perform pulse amplitude modulation and demodulation
6. To perform pulse position modulation and demodulation
7. To perform pulse width modulation and demodulation
8. To observe DSB, DSB-SC, SSB waveforms in time domain and frequency domain in MATLAB platform.
9. To observe DSB, DSB-SC, SSB waveform in time domain and frequency domain in MATLAB platform.
10. To design transmitter and receiver circuit for amplitude modulation using discrete components.
11. To design transmitter and receiver circuit for frequency modulation using discrete components.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. Morden Analog & Digital Communication System- B.P. Lathi
2. Digital and Analog Communication Systems– K. Sam Shanmugam.
3. Principle of Communication Systems- Taub & Schilling.
Reference:
4. Lab instruction manual
5. Instruction manuals provided by manufacturer</td></tr>
</table>

COURSE ARTICULATION MATRIX

Relating the **Course Outcomes** (COs) to the **Program Outcomes** (POs) &**Program Specific Outcomes** (PSOs):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
1	3	2	1	1	-	-	-	-	-	1	1	1	2	2	2
2	3	3	2	2	1	-	-	-	-	1	-	-	2	3	2
3	3	3	2	2	1	-	-	-	-	1	-	-	2	2	2
4	3	2	-	1	-	-	-	-	-	-	-	-	2	1	1
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) / 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>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) and end assessment (EA)):</td></tr>
<tr><td colspan="3">Basic Electronics (ECC01)</td><td colspan="5">Assignments, Mid Semester and End Semester Examination</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
DESIGN OF HALF ADDER AND HALF SUBTRACTOR CIRCUIT USING NAND GATES ONLY.

DESIGN OF 5-BIT EVEN / ODD PARITY CHECKER CIRCUIT USING XOR GATE.

Experiment: 2
• REALIZATION OF MULTIPLEXER AS UNIVERSAL LOGIC GATE.
• DESIGN FULL ADDER AND FULL SUBTRACTOR CIRCUIT USING4:1 MULTIPLEXER.

Experiment: 3
• REALISING A BCD TO DECIMAL DECODER CIRCUIT USING DECODER DRIVER AND SEVEN SEGMENT LED DISPLAY.
• VERIFYING THE FUNCTION TABLE OF 8 TO 3 LINE PRIORITY ENCODER.

Experiment: 4
• DESIGN OF FOUR BIT ONE’S COMPLEMENT BINARY ADDER / SUBTRACTOR CIRCUIT.
• DESIGN OF FOUR BIT TWO’S COMPLEMENT BINARY ADDER / SUBTRACTOR CIRCUIT.
• DESIGN OF FOUR AND FIVE BIT DIGITAL MAGNITUDE COMPARATOR.

Experiment: 5
• VERIFICATION OF EXCITATION TABLE OF J-K FLIPFLOP.
• VERIFICATION OF EXCITATION TABLE OF D FLIPFLOP.</td></tr>
</table>

	• DESIGN OF T TYPE FLIP FLOP FROM D TYPE FLIPFLOP. **Experiment: 6** • DESIGN OF ASYCHRONOUS UP COUNTER USING J-K FLIPFLOP. • DESIGN OF SYCHRONOUS UP COUNTER USING D FLIPFLOP. **Experiment: 7** • STUDY OF ASYNCHRONOUS DECADE COUNTER IC, 7490 IN DIFFERENT MODES. • STUDY OF ASYNCHRONOUS BINARY COUNTER OR MOD 16 COUNTER IC, 7493 IN DIFFERENT MODES. **Experiment: 8** • STUDY OF SYNCHRONOUS DECADE COUNTER IC, 74160 IN DIFFERENT MODES. • STUDY OF SYNCHRONOUS UP / DOWN COUNTER IC, 74192. **Experiment: 9** • STUDY OF 64-BIT READ / WRITE MEMORY. • STUDY OF 4-BIT UNIVERSAL SHIFT REGISTER. **Experiment: 10** • STUDY OF 4-BIT ARITHMATIC LOGIC UNIT.
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. REFERENCES 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) 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	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) / Electives (PEL)	Total Number of contact hours				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))					
ECC 303(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

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

Semester V

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	ECC501	Digital Communication	3-1-0	4
2	ECC502	Microwave Engineering	2-1-0	3
3	ECC503	Microprocessors and Microcontrollers	3-1-0	4
4	ECC504	Electronic Devices and Circuits II	3-1-0	4
5	YYO54*	Open Elective II	3-0-0	3
6	ECS551	Digital Communication Laboratory	0-0-3	1.5
7	ECS552	Microwave Engineering Laboratory	0-0-3	1.5
8	ECS553	Microprocessors and Microcontrollers Laboratory	0-0-3	1.5
9	XXS581	Co-curricular Activities V (Optional)	0-0-0	0
		Total:	**14-4-9**	**22.5**

<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) / 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>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) and end assessment (EA))</td></tr>
<tr><td colspan="2">Analog Communication(ECC401), Signals & Systems (ECC 303), Probability Theory</td><td colspan="6">Class Test, Assignments, Mid Semester Exam and End semester Exam</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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction [2L]
Introduction to digital communication, advantages of digital communication.
Waveform coding [6L+2T]
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.
Baseband transmission [7L+2T]
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.
Passband transmission [6L+2T]
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.
Review of Random Process [2L+1T]
Basic definition, Stationarity, Ergodicity, autocorrelation, cross correlation, power spectral density, Response of Linear systems to Random inputs, Gaussian process, Narrow band noise, Rayleigh pdf
Information theory and coding [7L+3T]
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. Modern Digital and Analog Communication Systems - B. P. Lathi, Z. Ding.
Reference Books:
1. Digital Communications - S. Haykin.
2. Digital Communications - B. Sklar.
3. A First course in Digital Communications - H. H. Nguyen, E. Shwedyk.</td></tr>
</table>

	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 Communication - J. G. Proakis, M. Salehi. 9. Theory and Design of Digital Communication Systems - T. T. Ha.

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Programme Outcome) and PSO (Program Specific 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	3	2	3	2	2	3	1	1	1	1	-	1	3	2	2
CO#2	2	2	2	3	2	3	2	1	1	1	-	1	2	3	3
CO#3	3	2	2	2	3	2	2	1	1	1	-	1	2	3	2
CO#4	2	3	3	3	3	2	1	1	1	2	-	2	3	2	2
CO#5	3	2	2	2	3	2	2	1	1	1	-	1	2	3	2
CO#6	3	2	3	2	2	3	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) / Electives (PEL)	Total Number of contact hours				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) and end assessment (EA))
Electromagnetic field theory, Transmission lines	Class Test, Assignments, Mid Semester Exam and End semester Exam

Course Outcomes

At the end of the course students will be able to:

- **CO#1**: Understand behavior of transmission lines and waveguides, gain complete knowledge about Microwave components.
- **CO#2**: Analyze and explain the characteristics of microwave passive components.
- **CO#3**: Analyze and explain the characteristics of microwave active components and circuits.
- **CO#4**: Acquire knowledge about the measurements at microwave frequencies.

Topics Covered

1. Propagation through rectangular and cylindrical circular waveguides, field configuration in waveguides, Dielectric waveguide and surface wave, Transmission line.**(6L)**
2. Concept of impedance in guided waves, Smith-chart and its use, Impedance matching techniques, single stub, double stub. **(4L)**
3. Cavity resonators and filters. **(4L)**
4. Network representations of discontinuities, scattering parameters and scattering matrices.**(4L)**
5. Microwave device and 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. Microwave Sources: Reflex klystron, magnetron, Gyratron, 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. Microwave Amplifiers: Klystron amplifiers, TWT – space TWT and Helix TWT. Measurement of microwave power, impedance, standing wave, frequency and phase-shift.Microwave antenna, Line of sight propagation, microwave links, satellite communication. **(12L)**

Text Books, and/or reference material

Text Books:

1. Collin, Robert E., “Foundations for microwave engineering 2/E”, John Wiley & Sons, 2007.
2. Liao, Samuel Y., “Microwave devices and circuits 3/E”, Pearson Education India, 1989.
3. D M Pozar, “Microwave Engineering”, Fifth Edition, Wiley India, New Delhi, India, 2005.

Reference Books:

1. Radmanesh, Matthew M., “Radio frequency and microwave electronics illustrated”, New Jersey: Prentice Hall, 2001.
2. CA Balanis, Advanced Electromagnetic Engineering, John Wiley, New York, 2003.
3. Cheng, David Keun, “Field and wave electromagnetics”, Pearson Education India, 1989.

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome), 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.

<table>
<tr><th colspan="8">Department of Electronics and Communication Engineering</th></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>ECC503</td><td>Microprocessors and Microcontrollers</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-semester assessment (MA) and end assessment (EA)):</td></tr>
<tr><td colspan="3">Digital Circuits and Systems (ECC402).</td><td colspan="5">Assignments, Mid-semester Examination and End Semester Examination</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To introduce students to the architecture and operation of typical microprocessors and microcontrollers.
• To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
• To provide strong foundation for designing real world applications using microprocessors and microcontrollers.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of the course, a student will be able to:
CO # 1. 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.
CO # 2. Understand the performance of Microprocessor (8085 & 8086) and Microcontroller based systems and select appropriate platform to meet specified requirements.
CO # 3. Apply the knowledge of Microprocessors, Microcontrollers and peripheral devicesand demonstrate the programming proficiency using the various instruction codes of the target microprocessor and microcontroller.
CO # 4. Analyze different problems on microprocessors and microcontrollers and write appropriate assembly language programs.
CO # 5. Evaluate the machine codes to providesolutions to the real-world problems.
CO # 6. Design necessary I/O and Memory interfacing circuitry to communicate Microprocessor and Microcontroller with external devices.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module – I: (L – 3; T -1)

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 –6; T - 2)

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.</td></tr>
</table>

	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 – 3; T - 1) **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 – 5; 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 – 5; 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** [T1]. Microprocessor, Architecture, Programming and Applications with Microprocessor 8085;Author: Ramesh S. Gaonkar (5^{th} Edition); Publisher – Prentice Hall **(Modules I)** [T2]. Advanced Microprocessors and Peripherals, Authors: A. K. Ray, K. M. Bhurchandi; Publisher - Tata McGraw Hill. **(Modules I – VI)** [T3]. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, Pearson Education. **(Modules VII)** [T4]. PIC Microcontrollers; Author - M. Bates; Publisher - Newnes. **(Module VIII)**

	[T5]. 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:** [R1]. Microprocessors and Interfacing: Programming and Hardware; Authors: Douglas V. HallPublisher - Tata McGraw Hill [R2]. The Intel Microprocessors – Architecture, Programming and Interfacing; Authors: Barry B. Brey; Publisher: Pearson Education [R3]. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed. [R4]. The 8051 Microcontroller: A Systems Approach; Authors: M.A. Mazidi, R.D. McKinlay, J.G. Mazidi; Publisher- Pearson. [R5]. Embedded microcontroller and processor design; Authors: G. Osborn; Publisher: Pearson [R6]. *Arduino Cookbook;* Authors: Michael Margolis, Publisher: O'Reilly Media, Inc, [R7]. W.A. Smith, "ARM Microcontroller Interfacing: Hardware and Software, Eketor, 2010.

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	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)

<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) / 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>ECC 504</td><td>Electronic Devices and Circuits-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) and end assessment (EA)):</td></tr>
<tr><td colspan="3">• Electronic Devices and Circuits I
• Basic Electronics
• Basic Course on Circuit Theory</td><td colspan="5">Assignments, Mid Semester and End Semester Examination</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Output Stages and Power Amplifiers (6L+1T)
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 (6L+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 (4L+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 (4L+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 and clampers, Schmitt triggers, precision rectifiers, peak detectors, Log and Antilog amplifiers, gyrator, Current to voltage and voltage to current converters, Instrumentation and</td></tr>
</table>

	isolation amplifiers, transducer Bridge amplifiers. General op−amp circuit design and detailed circuit description. **5. Signal Generator and Waveform-Shaping Circuits (4L+1T)** Op Amp-RC Oscillator Circuits; LC and Crystal Oscillators; Generation of Square and Triangular Waveforms Using Astable Multivibrators; 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 (3L)** 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:** 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) 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	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
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)

<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) / 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>ECS551</td><td>Digital Communication 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="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="2">ECS451 (Analog Communication Laboratory)</td><td colspan="6">CE+EA</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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7"><u>List of experiments</u>

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</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7"><u>Suggested Text Books</u>:
1. Introduction to Analog & Digital Communications - S. Haykin, M. Moher.
2. Digital Communication - J. G. Proakis, M. Salehi.
3. Lab. instruction manual.</td></tr>
</table>

COURSE ARTICULATION MATRIX

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

Department of Electronics and Communication 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	
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 Objectives	• To familiarize with different modes of rectangular waveguide. • To determine input impedance of unknown loads. • To understand the characteristics of different microwave components.
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 vs repeller 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.

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	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) / 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>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="2">Pre-requisites</td><td colspan="6">Course Assessment methods: (Continuous (CT) and end assessment (EA)):</td></tr>
<tr><td colspan="2">Digital Circuits and Systems (ECC402)</td><td colspan="6">Day to day evaluation during the laboratory session and End Semester Examination</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To provide practical exposure to the students to the operation of typical microprocessor and microcontroller trainer kits.
• To make the students capable to understand and solve different problems by designing required hardware circuitry and developing programming codes for the different problems.
• To give the knowledge of connecting interfacing devices with microprocessors and microcontrollers.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of thisseasonal course, a student will be able to:
CO # 1. Recognize the different parts of Microprocessors, Microcontrollers and peripheral devices.
CO # 2. Interpret methodologies to be adopted for the specified problems on Microprocessors and Microcontrollers.
CO # 3. Apply appropriate instruction codes to develop the program for Arithmetic, logical, data transfer and copying operations as well as data communication to external devices.
CO # 4. Analyze requirements of experimental setup of using Microprocessor and Microcontroller.
CO # 5. 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</td></tr>
</table>

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.
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** [T1]. Lab. instruction manual and operation manuals supplied by the manufacturers. [T2]. Microprocessor Architecture, Programming and Applications with the 8085; Authors: R. Gaonkar; Publisher -, Prentice Hall. [T3]. 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. [T4]. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, Pearson Education. [T5]. 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) 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	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)

Semester VI

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	HSC631	Economics and Management Accountancy	3-0-0	3
2	ECC601	Antenna and Wave Propagation	3-0-0	3
3	ECC602	VLSI Design	3-0-0	3
4	ECC603	Digital Signal Processing	3-1-0	4
5	ECE 610-625	Depth Elective I	3-0-0	3
6	ECE 610-625	Depth Elective II	3-0-0	3
7	ECS651	Antenna and Wave Propagation Laboratory	0-0-3	1.5
8	ECS652	VLSI Design Laboratory	0-0-3	1.5
9	ECS653	Digital Signal Processing Laboratory	0-0-3	1.5
10	XXS681	Co-curricular Activities VI (Optional)	0-0-0	0
		Total:	**18-1-9**	**23.5**

Department of Electronics and Communication 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	
HSC631	Economics and Management Accountancy	PCR	3	0	0	3	3
Pre-requisites- NIL		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					

Course Outcomes	• 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
Topics Covered	**Part 1: Economics** **Group A: Microeconomics** **Unit 1:** ***Economics: Basic Concepts (2L)*** (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 **Unit 2:** ***Theory of Consumer Behaviour(2L)*** (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 **Unit 3:** ***Theory of Production, Cost and Firms(3L)*** (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 **Unit 4:** ***Analyses of Market Structures: Perfect Competition(3L)*** (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 **Unit 5:** ***Monopoly Market (3L)*** (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 **Unit 6:** ***General Equilibrium and Welfare Economics(2L)*** (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

<table>
<tr><th colspan="8">Department of Electronics and Communication Engineering</th></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>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="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">Electromagnetic Theory and Transmission Lines (ECC403) and Microwave Engineering (ECC 502)</td><td colspan="6">Assignments, Mid-semester Examination and End Semester Examination</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To impart the fundamental concepts of Radiation phenomena and antenna parameters
• To analyse radiation characteristics of various antennas and antenna arrays as well as their applications
• To give the idea about basic radio wave propagation mechanisms</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of the course, a student will be able to:
CO # 1. Explain the concepts of antenna radiation patterns and various parameters for characterizing the antenna.
CO # 2. Understand different modes of radio wave propagation.
CO # 3. Classify various antennas on the basis of their electrical performances.
CO # 4. Analyze various antennas and antenna arrays.
CO # 5. Design antenna and antenna arrays for different applications.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I: (L – 1)

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 – 5)

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 – 5)

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.</td></tr>
</table>

[CO# 2, 4] [T1,T2]

Module IV: (L – 4)

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 – 3)

Microstrip Patch Antennas: Advantages and Limitations, Rectangular and circular types-function, features analysis,design considerations,Feeding methods, Method of analysis.[CO# 3, 4, 5] [T1]

Module VII: (L – 3)

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 – 5)

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 – 5)

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. **References** [R1]. R.E.Collin,"Antennas and Radiowave Propagation", Mc Graw 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 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	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><th colspan="8">Department of Electronics and Communication Engineering</th></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 : 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>ECC602</td><td>VLSI Design</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:
Physics of Semiconductor Devices (PHC331)
Electronic Devices and Circuits I (ECC302)
Digital Circuits and Systems (ECC402)
Introduction to Computing (CSC01)</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-semester examination (MS) and end assessment (EA))</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• Develop an ability to understand fundamental of VLSI, device model, small signal model current and voltage references.
• Develop an ability to understand CMOS Operational Amplifiers and Comparators.
• Develop an ability to understand Switched Capacitor Circuits, and digital to analog and analog to digital converters.
• Develop an ability to understand Layout Design of CMOS Cell.
• Develop an ability to understand VLSI Design Issues</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO#1:Demonstrate understanding of fundamental of VLSI, device model, small signal model current and voltage references.
CO#2:Demonstrate understanding of design goals and procedures of CMOS amplifiers such as 1- stage and 2-stage operational amplifiers and comparators.
CO#3:Design switched capacitor circuits such as switched capacitor amplifiers, integrators, filters, DACs and ADCs.
CO#4:Develop layout of digital, analog, and memory circuits based on layout design rules.
CO#5:Design digital, analog, memory circuits and subsystems keeping design issues in consideration.
CO#6:Design digital, analog, memory circuits and subsystems keeping design issues in consideration.</td></tr>
</table>

Syllabus/Topics Covered	**Module-I:** Introduction to VLSI: Fundamental of VLSI, CMOS Devices Modeling, Simple MOS Large Signal Model (SPICE) Parameters, Small Signal Model for the MOS Transistor, Computer Simulation Model, Sub threshold MOS Model, MOS Switch, MOS Diode/ Active resistor, Current Sink and Sources, Current Mirrors, Current and Voltage Reference, Bandgap Reference, Differential Amps, Cascode Amps, Current Amps. **Module-II:** CMOS Operational Amplifiers and Comparators: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two stage Op Amps, Power Rejection Ratio of Two Stage Op Amps, Cascode of Op Amps, Buffered Op Amps, High Speed/ Frequency Op Amps, Differential Output Op Amps, Micro Power Op Amps, Low Noise and Low Voltage Op Amp, Characteristics ofComparator, Two stage Open Loop Comparators, Discrete Time Comparators, High Speed Comparators. **Module-III:** Switched Capacitor Circuits, D/A and A/D: Switched Capacitor Circuits, Amplifiers and Integrators, Two Phase Switched Capacitor Circuits, First and Second Order Switched Capacitor Circuits, Switched Capacitor Filters, Comparative study of D/A, Parallel and Serial Digital Analog Converters, Serial Analog-Digital Converter, Medium, High Speed Analog-Digital Converter, Over sampling Converter. **Module-IV:** Layout Design of CMOS Cell: Schematic and Layout Design of Basic Gates and Universal Gates & Flip-Flop, Layout Representation, CMOS-N-Well Rules, Design Rules, Backgrounder, Layout Assignments, Latch-Up Problems, Analogue Design Layout Considerations, Transistor Design, Centroid Design, Capacitor Matching, Resistor Layout, Noise Considerations. **Module-V:** VLSI Design Issues: Design Captures Tools, HDL Design, Schematic Design, Layout design, Floor planning, Chip Composition, Design Verification Tools, Circuit Level Simulation, and Logic Level Simulation, Mixed Mode Simulators. Timing Verification, Network Isomorphism, Netlist Comparison, Layout Extraction, Back Annotation, Design Rule Verification, Pattern Generation, Data Sheets, Pin-out, Description Operation, DC Specification, AC Specification, and Package Diagram.

	Module-VI: Digital Subsystem Design: Design of Universal Gate using Pseudo-nMOS Logic, Clocked CMOS Single Bit Adder, Parallel Adder, Transmissions Gate Adders, Carry Look Ahead Adders, Other High Speed Adders, Multipliers, Asynchronous Counter, Synchronous Counter, SRAM Arrays, DRAM, ROM Array, Finite Stets Machines, Multilevel Logic.
Text / Ref. Books	Text Books: 1. Neil Weste& Harris, "CMOS VLSI Design: A Circuits and Systems Perspective," Fourth Edition, Addison-Wesley, 2010. 2. BehzadRazavi, "Design of analog CMOS integrated circuits," McGraw-Hill Education, Firth Edition, 2000. References: 1. R. Ramchandran,"Digital System Design," Springer 2007 2. Samir Palnitkar,"Verilog HDL," Second Edition, Pearson education, 2003

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program 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	-	-	1	-	-	2	2	1	1
CO#2	3	2	2	2	-	1	-	-	1	-	-	2	2	2	1
CO#3	2	2	2	2	3	1	1	-	1	-	-	1	2	2	2
CO#4	2	2	2	2	3	1	1	-	1	-	-	1	2	2	2
CO#5	2	2	2	2	3	1	1	-	1	-	-	1	2	2	2
CO#6	2	2	2	2	3	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)

<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) / 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>ECC603</td><td>Digital Signal Processing</td><td>PCR (Program Core)</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">Signals and Systems (ECC303), Mathematics-II & III (MAC MAC331)</td><td colspan="6">Class Assignments, Mid and End term examinations</td></tr>
<tr><td>Course Objective</td><td colspan="7">The course teaches Introduction to DSP; Digital Systems – Characterization, Description and Testing; FIR and IIR: Recursive and Non Recursive; Discrete Fourier Transform; Z Transform; Discrete Time Systems in Frequency Domain; Simple Digital Filters; Digital Processing of Continuous Time Signals; Analog Filter Design; Digital Filter Structure, Synthesis and Design</td></tr>
<tr><td>Course Outcomes

After going through the course, student will be able to</td><td colspan="7">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.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="7">Introduction: reasons behind digital processing of signals, brief historical development, organization of the course. (L=1)

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=3, 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=4, 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</td></tr>
</table>

	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=5, 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=5, 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=4, T=2) **Total: (L=36, T=14)= 40 Hrs.**
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) and PO (Program Outcome) & PSO (Program Specific 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	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)

<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) / 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>ECS651</td><td>Antenna and Wave Propagation Laboratory</td><td>PEL</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods: (Continuous (CT), and end assessment (EA)):</td></tr>
<tr><td colspan="2">Electromagnetic Theory and Transmission Lines (ECC403) and Microwave Engineering (ECC 502), Microwave Engineering Lab (ECS552)</td><td colspan="6">Day to day evaluation during the laboratory session and End Semester Examination</td></tr>
<tr><td>Course Objectives</td><td colspan="7">1. To provide the knowledge of EM wave propagation through guided medium and free space.
2. To learn the concepts of antennas and their basic parameters.
3. To know radiation characteristics of various kinds of antenna elements like, dipole, monopole, Loop, helical, micro-strip patches and measure their radiation parameters.
4. To introduce the concept of antenna arraying with the help of log periodic dipole antennas; also to impart the knowledge of antenna reflectors & directors by analyzing and plotting the radiation pattern of Yagi-Uda antenna.
5. To learn EM simulation software for designing antenna and operation of VNA for characterizing the designed antenna.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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.</td></tr>
<tr><td>List of Experiments</td><td colspan="7">1. To plot the radiation pattern of half wave dipole antennas.
2. To plot the radiation pattern of half wave monopole antenna.
3. To plot the radiation pattern of half wave folded dipole antenna.
4. To study the radiation characteristics of Yagi-Uda antenna.</td></tr>
</table>

	5. To the radiation characteristics of log periodic dipole antenna 6. To plot the radiation pattern of microstrip patch and slot antennas 7. Measurement of return loss of a given antenna using Network Analyzer 8. Study of radiation pattern of Horn antenna and understand the Friis transmission equation 9. To observe the characteristics of microstrip antenna using EM simulation software.
Text Books, and/or reference material	**References** [1]. Laboratory Instruction Manual and Operation Manual of the Manufacturer [2]. http://www.electronics-tutorial.net/lab-test-and-measurement/Antenna-and-Wave-Propagation/Exp-9/ [3]. Balanis, Antenna Theory and Design, Wiley Publications

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	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><th colspan="8">Department of Electronics and Communication Engineering</th></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 : 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>ECS652</td><td>VLSI Design Lab</td><td>Lab</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites:
Knowledge of Basic Electronics, Semiconductor Devices, and Digital Electronics</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• Develop an ability to understand fundamental of VLSI, device model, small signal model current and voltage references.
• Develop an ability to understand CMOS Operational Amplifiers and Comparators.
• Develop an ability to understand Switched Capacitor Circuits, and digital to analog and analog to digital converters.
• Develop an ability to understand Layout Design of CMOS Cell.
• Develop an ability to understand VLSI Design Issues</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO#1:Demonstrate understanding of fundamental of VLSI, device model, small signal model current and voltage references.
• CO#2:Understanding of Spice Simulation of Inverter, NAND, NOR Gates..
• CO#3:Familiarity with EDA tools for VLSI design /FPGA based system design.
• CO#4:Develop layout of digital, analog, and memory circuits based on layout design rules.
• CO#5:Design standard cells, CMOS XOR/XNOR Gates, full adder, Flip flops (R-S, D, J-K).
• CO#6:Design of register with tri-stated input/output bus and CPU with few instructions and implementation and validation on FPGA.</td></tr>
<tr><td>Reference Materials</td><td colspan="7">Samir Palnitkar, “Verilog HDL,” Second Edition, Pearson education 2003</td></tr>
</table>

Topic covered	List of experiments: 1. Familiarity with Spice simulation tool. 2. Spice Simulation of Inverter, NAND, NOR Gates. 3. Familiarity with EDA tools for VLSI design /FPGA based system design 4. Layouts, Transistors and tools. 5. Standards cell Design. 6. Design of CMOS XOR/XNOR Gates. 7. Design of CMOS Full adder. 8. Design of CMOS Flip flops (R-S, D, J-K). 9. Design of 8 bit synchronous Counter. 10. Design of 8 bit bi-directional register with tri-stated input/output bus. 11. Design of a 12 bit CPU with few instructions and implementation and Validation on FPGA.

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program 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	2	3	2
CO#2	2	2	2	2	3	1	-	-	1	-	-	1	2	3	2
CO#3	2	2	2	2	3	1	-	-	1	-	-	1	2	3	2
CO#4	2	2	2	2	3	1	-	-	1	-	-	1	2	3	2
CO#5	2	2	2	2	3	1	-	-	1	-	-	1	2	3	2
CO#6	2	2	2	2	3	-	-	-	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) / 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>ECS653</td><td>Digital Signal Processing Lab</td><td>PCR (Program Core)</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 (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">MATLAB, Signals & Systems (ECC 303)</td><td colspan="4">Quizzes and Lab Assessments</td></tr>
<tr><td>Course Objective</td><td colspan="6">To perform signals and systems analysis with Sampling, reconstruction and convolution of signals; Analyse the Difference equation and impulse response; Frequency domain analysis; Discrete Fourier Transform and Fast Fourier Transform analysis; Design Digital Filters</td></tr>
<tr><td>Course Outcomes After going through the course, student will be able to</td><td colspan="6">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</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="6">
A. Introduction to digital signals and systems:
<u>Experiment 1:</u>
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.
<u>Experiment 2:</u>
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:

<u>Experiment 3:</u>
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.
<u>Experiment 4:</u>
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:
</td></tr>
</table>

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

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

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

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; otherwise

Determine the DTFT for N=2, 5, 10, 15. Scale the DTFT so that $X\left(e^{j0}\right)=1$. 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

$y(n)=ay(n-1)+x(n);n\ge 0$

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 $\left|H\left(e^{jw}\right)\right|$ and $\angle H\left(e^{jw}\right)$.

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 $x\left\langle\langle n-3\rangle_9\right\rangle$ and $x\left\langle\langle n+3\rangle_9\right\rangle$.

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 $H_d\left(e^{j\omega}\right)=e^{-j\omega\tau};\omega_{c1}\le|\omega|\le\omega_{c2}$ $0;|\omega|<\omega_{c1},\omega_{c2}<|\omega|\le\pi$ Determine $H\left(e^{j\omega}\right)$ 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: $0.8\le\left\|H\left(e^{j\omega}\right)\right\|\le 1;|\omega|\le 0.2\pi$ $\left\|H\left(e^{j\omega}\right)\right\|\le 0.2;0.6\pi\le|\omega|\le\pi$ 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) and PO (Program Outcome) & PSO (Program Specific 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	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

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

DEPTH ELECTIVE BASKET

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

List of Depth Electives-6TH Semester

Sub Code	Subject Name	Sub Code	Subject Name
ECE610	Artificial Intelligence & Soft Computing	ECE618	Data Comm. & Computer Networks
ECE611	Computer Organization and Architecture	ECE619	Mobile Computing
ECE612	Advanced Digital Communication	ECE620	Nano Electronics
ECE613	Object Oriented Programming	ECE621	Measurement & Instrumentation
ECE614	CAD for VLSI	ECE622	Digital IC Design
ECE615	Active Filter Design	ECE623	Mechatronics Systems
ECE616	VLSI Technology	ECE624	Power Electronics
ECE617	Probability and Random Signal Theory	ECE625	Optical Communication

<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) / 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>ECE610/ ECO542</td><td>Artificial Intelligence and Soft Computing</td><td>PEL (ECE610) (Open Elective-ECO542)</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Objective</td><td colspan="6">The course teaches fundamentals of optimization and different optimization algorithms like Quantum particle swarm optimization, firefly algorithm, teaching learning based optimization algorithm etc. and its applications in engineering/other areas. It also teaches theory and applications of artificial neural network in regression, classification, forecasting etc.</td></tr>
<tr><td>Course Outcomes

After going through the course, student will be able to</td><td colspan="6">On successful completion of this course, students should have the skills and knowledge to:
CO1. Apply soft computing algorithms for solving unconstrained optimization problems.

CO2. Apply soft computing algorithms for solving constrained optimization problems.

CO3. Apply soft computing algorithms for solving different engineering problems.

CO4. Training, testing of multi-layer neural networks in regression, classification, forecasting.

CO5. Determine the center ,groups of data sets using K-means

CO6. Training, testing of Radial Basis Function Neural Networks (RBF) in regression, classification, forecasting.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="6">1. Introduction to optimization, Constrained and unconstrained optimization(02 hrs)

2. Single and multi-objective optimization, conventional optimization algorithms such as the method of steepest descent - classical newton's method (02 hrs)

3. Introduction to Optimization based on soft computing , Genetic algorithms, Quantum particle swarm optimization, Firefly algorithm(07 hrs)

4. Flower pollination algorithm,Teaching learning based optimization, Sine cosine algorithm, Gravitational search algorithm(07 hrs)

5. Introduction to artificial neural network, Supervised Learning Neural Networks,</td></tr>
</table>

	Perceptrons, Adaline, Multilayer feed forward neural network, Training of neural network using backpropagation algorithm, Training of neural network using soft computing technique **(08 hrs)** 6. Radial Basis Function Neural Networks(RBF),Training of RBF using pseudo inverse technique **,**Data clustering using K-means**(07hrs)**
Text Books, and/or Reference material	Text Books: 1. Principles of Soft Computing, S N Sivanandam, S. Sumathi, John Wiley & Sons 2. A beginners approach to Soft Computing, Samir Roy & Udit Chakraborty, Pearson 3. Neural Networks: A Classroom Approach,1/e by Kumar Satish, TMH 4. Neural Networks: A Comprehensive Foundation (2nd Edition), Simon Haykin, Prentice Hall.
	Reference Books/materials: 1. S. Rajasekaran and G.A.V.Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI 2. Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, PHI

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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	2	2	2	3	2	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="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) / 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>ECE611</td><td>Computer Organization and Architecture</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="4">Course Assessment methods</td></tr>
<tr><td colspan="3">ECC402
(Digital Circuits and Systems)
ECC503
(Microprocessors and Microcontrollers)</td><td colspan="4">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1. Evolution of computers: Hardware, software and firmware. Basics of computer architecture. Performance. Instruction sets and addressing methods. [6L]
2. Processing Unit: Registers, arithmetic and logic unit, fixed point and floating point operations. Bit slice architecture and processor. Coprocessor. [5L]
3. Control Unit: Hardware control unit, micro programmed control unit. Emulation, nanoprogramming. [3L]
4. Memory organization: Some typical memory devices, primary and secondary memories, memory interfacing, multiple module memories and interleaving, cache memory, associative memory, virtual memory and memory management techniques, paging and segmentation. [6L]
5. Input and Output organization: Commonly used I/O devices, addressing of I/O devices, I/O interfaces, concept of bus. [4L]
6. Advanced computer architectures: CISC & RISC architecture, distinction between CISC and RISC architecture, parallel processing- array processors and pipeline processors. Multiprocessors, data flow computer systems. [4L]
7. Case studies of typical computer systems. [2L]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">TEXT BOOKS
1. Computer architecture and organization- W. Stallings
2. Computer System Architecture - M. M. Mano
REFERENCE BOOKS
1. Computer architecture and Organization - J.P.Hayes
2. Computer Organization - Hamacher, Zaky & Vranesic</td></tr>
</table>

<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) / 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>ECE616</td><td>VLSI 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</td></tr>
<tr><td colspan="3">ECC01
(Basic Electronics)
PHC331
(Physics of Semiconductor Devices)</td><td colspan="5">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td colspan="3">Course Outcomes</td><td colspan="5">1. Knowledge of each basic process module.
2. Knowledge of IC process technology flow.
3. Understanding Bipolar IC and CMOS process technology flow.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module 1 [3L]
Introduction, Materials, Definitions, Scaling laws, Idea of Clean room, Si Substrate Growth.
Module 2 [3L]
Oxidation: Process of Oxidation, Types of Oxidation, Deal-Grove Model, Dependence of oxidation on different parameters, Applications in IC technology, LOCOS.
Module 3 [3L]
Lithography Module: Process flow of lithography, Components of Lithography, Aligner; Contact, Proximity, Projection, Metrics of Lithography, Photo resist-Positive and Negative, Mask, Next generation lithography.
Module 4 [6L]
• Diffusion: Basic Concepts, Diffusion in Si, Poly Si, Basic Process: Pre-deposition and Drive-in Diffusion, Junction Depth.
• Ion Implantation: Problems in Thermal Diffusion, Advantages of Ion Implantation, Ion Implantation system, Mechanism, Implatation Profile, Dose and Concentration relationship, Junction depth, Ion Implantation damage and annealing, Ion Channeling, Multi Implantation.
Module 5 [4L]
Thin Film Deposition: Introduction, Requirements of deposition, Methods: Physical Vapor Deposition and Chemical Vapor deposition, Step Coverage and Filling Issues.
Module 6 [3L]
Etching: Etch process, Requirements, Figure of merits, Types of Etch, Dry and Plasma Etch, Ion enhanced Etch.
Module 7 [4L]
Metallization: Interconnect, Interconnect requirements, Possible Interconnect materials, al metallization, Al spike problem, Hillocks and Voids, Electromigration Problems, Methods to reduce the problems, Metal silicides, Multilevel Metallization, W plugs for contact and vias, Intermetal Dilectrics.
Module 8 [4L]
IC process Integration: Simple Resistor, Capacitor, NMOS.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">1. VLSI Technology - S M Sze McGraw Hill.
2. Silicon Process Technology- S K Gandhi
3. Silicon VLSI Technology: Plummer, Deal and Griffin
4. Fundamental of Semiconductor Fabrication: Sze and May</td></tr>
</table>

<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) / 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>ECE620</td><td>Nano-Electronics</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="4">Course Assessment methods</td></tr>
<tr><td colspan="3">ECC302
(Electronic Devices and Circuits)
PHC331
(Physics of Semiconductor Devices)</td><td colspan="4">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td colspan="3">Course Outcomes</td><td colspan="4">1. Understand state of the art in semiconductor device physics and materials technology to enable the Nano-Electronics.
2. Apply the fundamentals of classical CMOS technology.
3. Implement the scaling of MOSFET in the sub-100nm regime.
4. Apprehend the need of non-classical transistors with new device structure and Nano-materials.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1. Introduction to nanotechnology, the size of things, history of nanotechnology, fabrication method (top-down and bottoms-up), emerging applications of nanotechnology
2. 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.
3. 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; Optoelectronic Devices using Nanostructures: Quantum well and Quantum Dot LASERS, Quantum Cascade LASER, Quantum well infrared photo detector, Super lattice LASER
4. 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.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens,Wiley (2003).
2. Nanoelectronics and Information Technology (Advanced Electronic Materials and Novel Devices), Waser Ranier,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</td></tr>
</table>

Department of Electronics and Communication 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	
ECE621	Measurements and Instrumentation	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	• CO1: **Understand** characteristics of general measurement system • CO2: **Apply qualitative analysis** techniques in general measurement system • CO3: **Apply quantitative analysis** techniques in general measurement system • CO4: **Understand** basic building blocks of general measurement system • CO5: **Design** general measurement systems with functional blocks • CO6: **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 [3L] 5. Sensing elements [5L] 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) 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	PSO1	PSO2	PSO3
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:
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				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE622	Digital IC Design	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous (CT), Mid-semester assessment (MA) and end assessment (EA)):					
Digital Circuits and Systems (ECC402).		Assignments, Mid-semester Examination and End Semester Examination					

Course Objectives	• The student is able to evaluate characteristics of CMOS inverter and interconnects specifically in terms of current and capacitance that are essential for estimating delay and power. • The student is able to quickly estimate the best number of stages for a path, the minimum possible delay for the given topology, and the gate sizes that achieve this delay using logical effort. • The student is able to understand the fundamental theory behind various sources of power dissipation in a CMOS chip and apply techniques to minimize that. • The student is able to optimize combinational circuits for lower delay and/or energy; analyze sequential circuits including clocking and latching techniques. • The student is able to use Electronic Design Automation (EDA) tools in VLSI and experiment with the current technology/process, and able to design state-of-the-art CMOS circuits.
Course Outcomes	At the end of the course, a student will be able to: CO#1: Understand the characteristics of CMOS inverter and interconnects. CO#2: Understand the fundamental theory behind various sources of power dissipation and apply techniques to minimize it. CO#3: Learn the basic steps of fabrication process. CO#4: Analyze the performance of CMOS inverter circuits. CO#5: Study the Static and dynamic characteristics of MOS inverter CO#6: Understand the recent trends in VLSI Design & its research issues in industry/ academia
Topics Covered	**Module-I:** (L – 4; T -0) **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. **Module-II:** (L – 4; T -0)

	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 – 4; T -0) **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 – 2; T -0) **Modelling of MOS Transistors:** Basic concepts, state-of-art MOSFET models, capacitance models, comparison of SPICE MOSFET models. **Module-V:** (L – 2; T -0) **MOS Inverter (Static Characteristics):** Resistive-load inverter, inverter with n-type MOSFET load, CMOS inverter. **Module-VI:** (L – 4; T -0) **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 – 2; T -0) **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 – 2; T -0) **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 – 4; T -0) **Dynamic logic Circuits:** basic principle of pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, dynamic CMOS circuit techniques, high-performance dynamic CMOS circuits. **Module-X:** (L – 2; T -0) **Semiconductor Memories:** Memory Design, SRAM, DRAM structure and implementations. **Module-XI:** (L – 4; T -0) **Recent Trends in VLSI Design & its research issues in industry:** System case studies. Design automation of VLSI Systems: basic concepts. Deep Sub-micron Technologies: Some Design Issues.
Text Books, and/or reference material	TEXT BOOK 1. CMOS Digital Integrated Circuits, Sung-Mo Kang,Yusuf Leblebici, 3rd edition, Tata McGraw-Hill, 2003 REFERENCES 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), PO (Programme Outcome) and PSO (Programme Specific 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	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)

Department of Electronics and Communication 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	
ECE623	Mechatronics Systems	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+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 [7L] Signal Conditioning circuits [4L] Digital Processing Elements [2L] 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) 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	PSO1	PSO2	PSO3
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)

<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) / 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>ECE624</td><td>Power Electronics</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="4">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic Electronics (ECC01)
Signals and Systems (ECC303)</td><td colspan="4">CT+EA</td></tr>
<tr><td>Course Objectives</td><td colspan="6">• To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
• To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
• To provide strong foundation for further study of power electronic circuits and systems.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: To understand the basics of Power Electronics.
• CO2: To learn the details of power semiconductor switches (Construction, Characteristics and operation).
• CO3: To understand the working of various types of converters.
• CO4: To learn how to analyse the converters and design the components of them, under various load types.
• CO5: 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.</td></tr>
</table>

Topics Covered	1. Concept of power electronics, application of power electronics, advantages and disadvantages of power electronics converters, power electronics systems. 2. Power diodes, Its characteristics, types. 3. Power transistors: Power MOSFETs, characteristics, comparison with BJT, IGBT, characteristics. 4. Study the characteristics and applications of switching devices like Diode, SCR (Thyristor), TRIAC 5. Triggering and commutation circuit for SCR- Design of Driver and snubber circuit. 6. Gate characteristics, ratings, Different commutation techniques of SCR. 7. Brief description of members of thyristor family with symbol, GTO. 8. Brief Discussion about uncontrolled converters (Diode rectifiers). 9. DC-DC converters: Principle of operation, control strategies. 10. Principle of operation of single phase half wave uncontrolled rectifiers with R, RL and RLE load, effects of freewheeling diodes. Calculation of performance parameters 11. Single phase half-wave rectifier with resistive and R-C load using diode, 12. Single phase full-wave rectifier with R-C filter 13. Single phase half-wave rectifier with R-L load 14. single phase full wave rectifier with R-L load 15. Three phase half wave rectifier with resistive load 16. Brief discussion about Controlled Rectifier using Thyristor 17. Single phase half wave rectifier with resistive load using thyristor, 18. Single phase semi-converter with inductive load, 19. Single phase full converter with inductive load 20. Single phase dual converter 21. Three phase half wave controlled rectifier with resistive and inductive load 22. Three phase half controlled bridge rectifier with resistive load 23. Three phase full wave converter with inductive load 24. Applications of controlled rectifier using thyristor 25. Inverters: Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. 26. Single phase voltage source inverters– voltage & harmonic control--PWM techniques 27. Sinusoidal PWM, modified sinusoidal PWM 28. Multiple PWM 29. Introduction to space vector modulation 30. Current source inverter.
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.

	REFERENCES 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, Mc Graw Hill, 3rd Print.

<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) / 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>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="2">Pre-requisites</td><td colspan="5">Course Assessment methods</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1. Introduction to fiber optics, principles of optical fiber. [4L]
2. Optical fiber characteristics, types of optical fibers. [8L]
3. Fiber optic components, optical sensors, optical detectors. [6L]
4. Principles of fiber optic communication, long haul communication, optical LAN, bandwidth and rise time budget, power budget. [8L]
5. Fiber optic sensors for medical applications. [2L]
6. Free space optical communication. [2L]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">[1] Henry Zanger and Cynthia Zanger, Fiber Optics Communication and Other Application, Macmillan Publishing Company, Singapore 1991.
[2] G. Keiser, Optical Fiber Communication, McGraw Hill, 3rd Ed.
[3] J. M. Senior, Optical Fiber Communications, PHI, 2nd Ed.</td></tr>
</table>

Semester VII

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	MSC731	Principles of Management	3-0-0	3
2	ECE710-725	Depth Elective III	3-0-0	3
3	ECE710-725	Depth Elective IV	3-0-0	3
4	ECE710-725	Depth Elective V	3-0-0	3
5	YYO74*	Open Elective III	3-0-0	3
6	ECS751	Computer Aided Design Laboratory	0-0-3	1.5
7	ECS752	Electronic System Design Laboratory	0-0-4	2
8	ECS753	Advanced Communication Laboratory	0-0-3	1.5
9	ECS754	Vocational Training / Summer Internship and Seminar	0-0-2	1
10	ECS755	Project – I	0-0-3	1
		Total:	**15-0-15**	**22**

Department of Electronics and Communication 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	
MSC731	PRINCIPLES OF MANAGEMENT	PCR	3	0	0	3	3
Pre-requisites- NIL		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					

Course Outcomes	• CO1:To impart knowledge on various tools and techniques applied by the executives of an organization • CO2:To make potential engineers aware of managerial function so that it would help for their professional career • CO3:To impart knowledge on organizational activities operational and strategic both in nature • C04: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science and 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 Financial accounting, Analysis of Financial statements, 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 edition (Quality control, Forecasting), Buffa & Sarin, Willey

COURSE ARTICULATION MATRIX

	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	3	3	-	1	-	-	-	-	-	-	3	1
CO#2	-	-	-	-	-	-	-	-	-	2	-	3	1	1	2
CO#3	-	-	-	-	-	-	2	3	-	-	-	-	3	-	2
CO#4	2	2	-	2	2	2	-	2	2	1	3	-	2	2	3

<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) / Electives (PEL)/ Lab</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>ECS751</td><td>Computer Aided Design Lab</td><td>Lab</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">EDC I, II (ECC 302, ECC 504), VLSI Design (ECC 602)</td><td colspan="5">Quiz and Lab Assessments</td></tr>
<tr><td>Course Objective</td><td colspan="7">In this course students learn to design and simulate electronic circuits. Students use Computer Aided Design tools to design analog and digital integrated circuits and verify the design using simulation tools.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After successful completion of experiments, students will be able to:
• CO#1:Understand simple Op Amp design
• CO#2:Understand principles of Amplifier, switch capacitor and oscillator designs
• CO#3:Design Wien-Bridge and Two Integrator Oscillators using Op Amp circuits
• CO#4:Design Bistable Circuit, Astable Multivibrator and Saw-Tooth Waveform generator
• CO#5: Analyze and design Colpitts, Crystal Oscillator, Current Starved VCO, Relaxation Oscillator and Multi-vibrator as VCO
• CO#6:Apply a method for analyzing noise figure and equivalent input noise density of linear electronic circuits</td></tr>
<tr><td>Topics Covered</td><td colspan="7">List of Experiments:
1. To verify the characteristics of Op Amp design
2. Synthesis and simulation of basic gates
3. Synthesis and simulation of Full Adder
4. To verify the characteristics of Wien-Bridge and two integrator oscillator using Op Amp circuits
5. Design Bistable Circuit, Astable Multivibrator and Saw-Tooth Waveform generator
6. Design Colpitts, Crystal Oscillator, Current Starved VCO, Relaxation Oscillator and Multi-vibrator as VCO
7. Study of linear electronic circuits
8. Synthesis and simulation of Full Subtractor
9. Synthesis and simulation of 3×8 decoder
10. Synthesis and simulation of 8×1 Mux and DeMux.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS
1. Laboratory Instruction Manual
2. Sedra/Smith, Microelectronic Circuits, Oxford University Press, Seventh Edition

REFERENCE BOOKS
1. Applications of analog integrated circuits - Sidney Soclof , PHI
2. Microelectronics. Jacob Millman, Arvin Grabel. McGraw-Hill</td></tr>
</table>

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program 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	2	1
CO#2	3	2	2	1	-	1	-	-	1	1	-	1	2	2	1
CO#3	3	3	3	1	2	2	1	-	1	-	-	1	3	3	2
CO#4	3	3	3	1	2	2	1	-	1	-	-	1	3	3	2
CO#5	2	3	1	2	2	1	1	-	1	-	-	1	3	3	2
CO#6	2	2	2	1	1	-	-	-	1	-	-	1	2	1	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) / 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>ECS752</td><td>Electronic system design</td><td>PCR</td><td>0</td><td>0</td><td>4</td><td>4</td><td>2</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Electronic devices & circuits I, II (ECC302, ECC504), Electrical Technology (EEC 01)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• 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="6">• 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="6">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 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	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)

<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) / 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>ECS753</td><td>Advanced Communication lab</td><td>PEL (Open Elective)</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Objective</td><td colspan="6">The course teaches Monte Carlo Simulation on Communication related problems</td></tr>
<tr><td>Course Outcomes

After going through the course, student will be able to</td><td colspan="6">On successful completion of this course, students should have the skills and knowledge to :

CO1. Understand Monte Carlo Simulation of Discrete and Continuous random variables

CO2. Estimate Bit Error Rate (BER) of a Communication Systems

CO3. Evaluate the performance of simple modulation over AWGN and Fading Channel (typically Rayleigh and other)

CO4. Model fading channels and understand Digital Communication concepts in context to fading channels.

CO5. Assess the performance of simple Network Access protocols like ALOHA and S-ALOHA by simulation.

CO6. Develop expertise in writing program using MATLAB and tools like SIMULINK.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="6">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).</td></tr>
</table>

	Plot the BER vs Eb/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, Masud Salehi and Gerhard Bauch, Third Ediation, CENGAGE Learning

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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)

DEPTH ELECTIVE BASKET

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

List of Depth Electives-7TH Semester

Sub Code	Subject Name	Sub Code	Subject Name
ECE710	Detection and Estimation Theory	ECE718	Satellite Communication
ECE711	Information Theory & Coding	ECE719	Telecommunication Networks
ECE712	Analog IC Design	ECE720	Advanced Semiconductor Devices
ECE713	FPGA Based Design	ECE721	Random Processes
ECE714	MEMS and Microsystems Technology	ECE722	Microwave Circuits & Techniques
ECE715	Machine Learning	ECE723	Semiconductor Device Modelling
ECE716	Millimeter Wave Technology	ECE724	Biomedical Instrumentation
ECE717	RF ID Technology and Applications	ECE725	Adhoc and Sensor Networks

<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) / 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>ECE711</td><td>Information Theory & Coding</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Objectives</td><td colspan="7">To understand the role of information theory for an efficient, error-free and secure delivery of information using binary data streams.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO.1Understand the concept of Information and quantitative from of characterization of information
CO.2Understand abstraction of digital information transfer and characterize storage/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 of Communication systems. Analyze Capacity of Various Channels.
CO.5Understand the fundamental difference between Source Coding theorem and Channel Coding theorem.
CO.6Understand different approaches for error correction and suitability of their Application. Develop understanding of Block Coding.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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. (8L)

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. (9L)

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)</td></tr>
</table>

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) and PO & PSO

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	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)

Department of Electronics and Communication 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	
ECE714	MEMS and Microsystems Technology	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+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 4L Lumped Modeling, Statics, Dynamics 5L Quasi static analysis 2L 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 Books: 1. Microsystem Design by Stephen D. Senturia, Springer Reference Books: 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) 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	PSO1	PSO2	PSO3
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:

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				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECE718	Satellite Communication	PEL	3	0	0	3	3
Pre-requisites		Course Assessment Methods					
ECC401 (Analog Communication) ECC501 (Digital Communication)		Continuous (CT) and End Assessment (EA)					

Topics Covered

UNIT I - SATELLITE ORBITS:-[7L]

Kepler's Laws, Orbital parameters, Orbital perturbations, Station keeping, Geo- stationary and non-Geo-stationary orbits, Look Angle Determination, Limits of visibility –eclipse-Sub satellite point , Sun transit outage-Launching Procedures - launch vehicles and propulsion.

UNIT II - SPACE SEGMENT AND SATELLITE LINK DESIGN: - [10L]

Spacecraft Technology - Structure, Primary power, Attitude and Orbit control(AOCS) Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command(TT&C), spacecraft antenna, transponder, Friis transmission equation, G/T ratio of earth station.

Satellite uplink and downlink Analysis and Design, link budget, E/N calculation- performance impairments-system noise, inter modulation and interference, Propagation Characteristics and Frequency considerations-System reliability and design lifetime.

UNIT III - SATELLITE ACCESS (Multiple access techniques for satellite links):-[3L]

Multiple access- FDMA, TDMA, CDMA techniques, comparison of multiple access techniques, error correcting codes.

Spread Spectrum communication, compression – encryption

UNIT IV - EARTH SEGMENT:-[7L]

Introduction – Receive – Only home TV systems – Outdoor unit – Indoor unit for analog (FM) TV – Master antenna TV system (MATV) – Community antenna TV (CATV) system – Transmit – Receive earth stations – Problems

Equivalent isotropic radiated power(EIRP), – Transmission losses – Free-space transmission – Feeder losses – Antenna misalignment losses – Fixed atmospheric and ionospheric losses – Link power budget equation – System noise – Antenna noise – Amplifier noise temperature – Amplifiers in cascade – Noise factor – Noise temperature of absorptive networks – Overall system noise temperature – Carrier to- Noise ratio (C/No) – Uplink – Saturation flux density – Input back off – The earth station - HPA – Downlink – Output back off – Satellite TWTA output – Effects of rain – Uplink rain– Fade margin – Downlink rain – Fade margin – Combined uplink and downlink C/N ratio – Inter modulation noise.

UNIT V-SATELLITE APPLICATIONS: - [5L]

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), Digital audio broadcast (DAB)- Business TV(BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet.

<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) / 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>ECE719</td><td>Telecommunication 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) and end assessment (EA))</td></tr>
<tr><td colspan="2">ECC401 (Analog Communication)
ECC501 (Digital Communication)</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Learn about various types of networks appropriate for pre specified applications and operational scenarios.
• CO2: Explain the information flow through various subsystems of a network.
• CO3: Understand the current technology trends and business potential of future telecommunication networking paradigms.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Elements of telecommunication network. (2L)
Computer networks. (8L)
Landline telephone networks. (8L)
Cellular mobile networks. (8L)
Optical networks. (8L)
Satellite networks. (8L)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS
1. Communication Networks - J. Walrand.
REFERENCE BOOKS
1. Telecommunication Switching and Networks - P. Gnanasivam.
2. Optical and Wireless Communications – M. N.O. Sadiku.</td></tr>
</table>

<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) / 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>ECE720</td><td>Advanced Semiconductor Devices</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="4">Course Assessment Methods</td></tr>
<tr><td colspan="3">PHC331 (Physics of Semiconductor Devices)</td><td colspan="4">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1. Electronic properties and technologies of semiconductor Devices : SiGe and Group III-V compound semiconductors; Advanced Heterojunction bipolar Transistor (HBT) Devices: SiGe, GaAs, InP, GaN
2. Advanced Field Effect Devices: Heterostructure Field Effect Transistors (HFETs), Modulation Doped Field Effect Transistors (MODFETs), High Electron Mobility Transistors (HEMTs)
3. Resonant Tunneling Devices (RTDs); Single Electron Transistors (SETs)
4. Strained layer supper lattices and quantum well devices; RF & digital applications; Noise Characteristics
5. HBT Modelling; Heterojunction device simulation</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">1. Theory of Modern Electronic Semiconductor Devices, Kevin F. Brennan, April S. Brown, 2002 John Wiley & Sons, Inc.
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.</td></tr>
</table>

<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) / 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>ECE722</td><td>Microwave Circuits and Techniques</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</td></tr>
<tr><td colspan="3">ECC502 (Microwave Engineering)</td><td colspan="5">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module 1 [6L]
RF/ Microwave Passive Components: Lumped Elements: Equivalent circuits. RF Integrated Circuits: Lumped element approach. RFIC Simulation tools.
Planer Lumped Elements, Planer capacitors, Planer resistors. Transmission Lines, Microstrip and coplanar lines for MMIC’s Line discontinuities. MMIC
Module 2 [6L]
Network Parameters Z,Y, Properties of S parameters, Relationship between s-parameters and other parameters like ABCD parameters.
Noise Parameters Thermal noise, Shot noise in two-port network, Noise figure and Smith chart, Noise temperature. Noise figure and noise voltage.
Module 3 [8L]
Circuit analysis techniques for high frequency integrated circuits: Impedance matching, tuned circuit topologies and analysis techniques, techniques to maximize bandwidth, challenges in differential circuits at high frequency, non-linear techniques.
Module 4 [8L]
Microwave Solid – State Active Devices for MICs: Schottky Barrier diode, Pin diode, Varactor diode – structure, characteristics, operation, equivalent circuit , gain expression and output power efficiency and applications. Bipolars, MESFETs and HEMTs.
Module 5 [8L]
Power amplifier, lwo noise amplifier, mixer, other control circuits and voltage controlled oscillator.
Module 6 [4L]
Processing, MMIC performance, MMIC status, GaAs MMIC reliability, Yield cost, Future developments, MMIC applications: Military, Commercial and Consumer applications.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS

[1] High Frequency integrated Circuits, Sorin Voinigescu, 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</td></tr>
</table>

<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) / 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>ECE723</td><td>Semiconductor Device Modelling</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</td></tr>
<tr><td colspan="3">PHC331
(Physics of Semiconductor Devices)
ECC302
(Electronic Devices and Circuits)</td><td colspan="5">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Concentration and motion of carriers in Semiconductor bulk - equilibrium concentration in intrinsic and extrinsic semiconductors, excess carriers, drift and diffusion transport, continuity equation.
2. Concentration and motion of carriers at the interface - surface recombination, surface mobility etc.
3. Device modelling - basic equations for device analysis, approximation to these equations for deriving analytical expressions.
4. PN homo-junction - ideal static I-V characteristics and deviations including breakdown, ac small signal equivalent circuit, switching characteristics.
5. MIS Junction/capacitor - ideal C-V characteristics and deviations due to interface states/charges and work function differences, threshold voltage.
6. BJT - transistor action, static characteristics, ac small signal equivalent circuit, switching characteristics.
7. FETs - field effect, types of transistors (JFET, MESFET, MISFET), static characteristics of MISFET, small signal equivalent circuit, difference between BJT and FETS.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">1. B. G. Streetman and S. Banerjee, Solid State Electronic Devices, PHI.
2. S. M. Sze, Physics of Semiconductor Devices, John Wiley & Sons.
3. S. M. Sze, Semiconductor Devices: Physics and Technology, John Wiley & Sons.
4. Michael Shur, Physics of Semiconductor Devices, PHI.
5. Nandita DasGupta and Amitava DasGupta, Semiconductor Devices, PHI.
6. C. T. Sah, Fundamentals of Solid State Electronics, World Scientific.</td></tr>
</table>

Semester VIII

Sl. No.	Subject code	Name of the Subject	L T P	CP
1	ECE810-825	Depth Elective VI	3-0-0	3
2	YYO84*	Open Elective IV	3-0-0	3
3	YYO84*	Open Elective V	3-0-0	3
4	ECS851	Project – II	0-0-15	5
5	ECS852	Project Seminar	0-0-0	1
6	ECS853	Comprehensive Viva Voce	0-0-0	1
		Total:	**9-0-15**	**16**

DEPTH ELECTIVE BASKET

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

List of Depth Electives-8TH Semester

Sub Code	Subject Name	Sub Code	Subject Name
ECE810	Wireless Communication	ECE818	VLSI System Design
ECE811	Mixed Signal IC Design	ECE819	RF IC Design
ECE812	Radar Engineering	ECE820	Low Power Circuits & Systems
ECE813	Digital Image Processing	ECE821	Advanced Antenna Synthesis
ECE814	Error Control Coding	ECE822	DSP Architectures in VLSI
ECE815	Embedded System Design	ECE823	Internet of Things (IoT) Technology
ECE816	RF and MMIC	ECE824	VLSI Testing and Verification
ECE817	Design with Op. Amps. & Analog Integrated Circuits	ECE825	Statistical Signal Processing

<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) / 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>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="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Objective</td><td colspan="7">The course teaches fundamentals of Wireless Communication like Cellular Systems, Wireless Channel models and some Fundamental Physical layer issues</td></tr>
<tr><td>Course Outcomes

After going through the course, student will be able to</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 for Wireless 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,</td></tr>
</table>

	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**(05 hrs)** 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)**
Text Books, and/or Reference material	Text Books: 1.Wireless Communications: Principles and Practice: Theodore Rappaport, Pearson, 2nd Edition 2.Wireless Communication : Andrea Goldsmith, Cambridge University Press
	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

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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)

<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) / 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>ECE812</td><td>Radar Engineering</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="4">Course Assessment methods</td></tr>
<tr><td colspan="3">ECC401
(Analog Communication)
ECC501
(Digital Communication)
ECC603
(Digital Signal Processing)</td><td colspan="4">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="6"><u>Module –I: Introduction to Radar [6L]</u>

Historical background, radar terminology, radar band designations, Radar block diagram, Radar equation: detection of signals in noise and signal-to-noise ratio, Probabilities of detection & False alarm, integration of radar pulses, radar cross section, distributed targets, Transmitted power, pulse-repetition frequency, antenna parameters & system losses, introduction to radar clutter.

<u>Module – II: Radar Types [8L]</u>

Pulse radars and CW radars, Advantages of coherent radar, Doppler radar and MTI(Moving Target Indicators): Doppler effect, delay-line cancellers, blind speeds, staggered PRFs(Pulse repetition frequency), Digital filter bank, Moving Target Detector, limitations of MTI, tracking with radar, monopulse tracking, conical scan, limitation to tracking accuracy.

<u>Module –III: Radar signals & clutter [10L]</u>

Basic radar measurement, theoretical accuracy of radar measurements, Range and velocity ambiguities, the ambiguity diagram, pulse compression-principles, the matched filter, chirp waveforms, Waveform design: nonlinear FM, phase codes, waveform generation and compression Descriptions of land & sea clutter, statistical models for surface clutter, detection of targets in clutter.

<u>Module –IV: Devices and Radar Systems [8L]</u>

Radar transmitter: Solid-state RF power source, Magnetron, other RF power sources, Radar receiver: Super heterodyne receiver, receiver noise figure, duplexers & diplexers, Receiver protectors, Applications: Electronic Warfare: ESM(Electronic Support Measures), ECM(Electronic counter measure), ECCM(Electronic counter counter-measure); super resolution, IFM(Instantaneous Frequency Measurement), types of jammers, Stealth and counterstealth: stealth techniques for aircraft and other target types, low frequency and UWB radar, System design examples.</td></tr>
</table>

<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) / 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>ECE 813</td><td>Digital Image Processing</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Signals and Systems(ECC 303), Digital Circuits and Systems(ECC402), Digital Signal Processing(ECC603),</td><td colspan="6">Class Test , Mid and End term examinations</td></tr>
<tr><td colspan="2">Course Outcomes</td><td colspan="6">• 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.</td></tr>
<tr><td colspan="2">Topics Covered mapped to Course Outcomes</td><td colspan="3"><u>Topic Details</u></td><td><u>(No. of classes)</u></td><td><u>Course Outcomes (COs)</u></td></tr>
<tr><td colspan="2"></td><td colspan="3">Digital Image Fundamentals: Image acquisition, Sampling, Quantization, Resolution, Relationship between pixels, Geometric transforms, Convolution and Correlation.</td><td>3</td><td>CO#1</td></tr>
<tr><td colspan="2"></td><td colspan="3">Image Enhancement: Gray level intensity transforms, Histogram processing, Image sharpening and smoothening operations (spatial and frequency based).</td><td>5</td><td>CO#1</td></tr>
<tr><td colspan="2"></td><td colspan="3">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.</td><td>4</td><td>CO#1</td></tr>
<tr><td colspan="2"></td><td colspan="3">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.</td><td>4</td><td>CO#2,CO#4</td></tr>
<tr><td colspan="2"></td><td colspan="3">Compression and Encoding of Image: Redundancy, Entropy coding, Lossy compression, Lossless compression,</td><td>3</td><td>CO#1, CO#4</td></tr>
</table>

	Quality preserving adaptive compression. **Morphological Processing**: Dilation and erosion, Opening and closing, Hit or Miss transform, Algorithms for feature extraction. **Image Segmentation**: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation, Segmentation by morphological watersheds, Use of motion in segmentation. **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.	3 4 4	CO#3, CO#4 CO#3, CO#4 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

Relating the **Course Outcomes** (COs) to the **Program Outcomes** (POs) & **Program Specific Outcomes** (PSOs):

CO	Statement	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
ECE 813.1	Understand image enhancement and restoration techniques	3	3	3	3	3	-	-	-	2	-	1	-	3	3	1
ECE 813.2	Analyze digital images through multiresolution techniques	3	3	3	3	3	-	-	-	2	-	1	-	3	3	1
ECE 813.3	Understand the application of morphological processing and segmentation of digital images	2	3	3	3	2	-	-	-	1	-	1	-	3	3	1
ECE 813.4	Ability to interpret digital image recognition techniques	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)

PROGRAM ARTICULATION MATRIX

Course	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
ECE 813	Y	Y	Y	Y	Y	-	-	-	Y	-	Y	-	Y	Y	Y

<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) / 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>ECE814</td><td>Error Control Coding</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</td></tr>
<tr><td colspan="3">ECC402
(Digital Circuits and Systems)
ECC501
(Digital Communication)</td><td colspan="5">Continuous (CT) and End Assessment (EA)</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Introduction to Linear Algebra: Group, Ring, Field, Vector Space. [6L]
2. Binary Linear Block Codes : Generator and Parity Check Matrices, Dual Codes, Decoding, General properties of linear block codes, Hamming Code. [7L]
3. Cyclic Codes: Algebraic description, Encoding and Decoding of Cyclic codes [3L]
4. BCH Codes: Properties, Encoding and Decoding, Euclidean Algorithm. [2L]
5. Reed Solomon (RS) Codes: Definition, Decoding of RS codes. [1L]
6. Convolution Codes: Definition, Encoding Trellis and State representation, Viterbi decoding, Error probability. [6L]
7. LDPC Codes : Definition, Construction, Regular and irregular LDPC, Belief Propagation, Tanner Graph, Decoding, Iterative Decoding [3L]
8. Turbo Codes: Definition, Construction methods, Decoding [3L]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">TEXT BOOKS

1. Error Control Coding; Fundamentals and applications: Shu Lin and Daniel.J.Costello Jr. Second Edition, Pearson India.
2. Essentials of Error Control Coding by Moreira and Farrel, Wiley India

REFERENCE BOOKS

1. Error Correction Coding: Mathematical Methods and Algorithms by Todd.K. Moon, Wiley India.</td></tr>
</table>

OPEN ELECTIVE BASKET

THE STUDENTS CAN OPT FROM ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER, EXCEPT THE SUBJECTS WITH HIS/HER OWN DEPARTMENT CODE

List of Open / Width Electives

Semester of Study	Subject Code	Subject Name
4TH	ECO440	Digital Systems
	ECO441	Communication Engineering
5TH	ECO540	Mechatronics
	ECO541	Probability Theory For Engineering Application
	ECO542	Artificial Intelligence And Soft Computing
6TH	ECO640	Structronics
	ECO641	Signal Processing
	ECO642	Introduction To VLSI
7TH	ECO740	Biomedical Instrumentation
	ECO741	Embedded Systems
8TH	ECO840	Communication Network
	ECO841	Mobile Computing
	ECO842	MEMs Technology

<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) / 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>ECO441</td><td>Communication Engineering</td><td>PEL (Open Elective)</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Identify the methods of communications.
• CO2: Analyze the methods of communications.
• CO3: Apply wired or wireless communication in proper context.
• CO4: Demonstrate the use of communication in different industrial scenarios.
• CO5: Recognize the current technology trends in communication engineering.
• CO6: Design future communication systems.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Module 1: Basics of communication engineering [2 hrs.]
Elements of a communication system.
Evolution of communication systems.
Challenges and limitations of communication systems.
Wired, wireless and storage channels.

Module 2: Wired communication [8 hrs.]
Telephone: Base and handset, Dialling and signalling, Subscriber loop.
Analog and Digital Signals.
Sampling: Nyquist’s theorem, Aliasing, Time division multiplexing.
PCM: Generation, Regenerative transmission, Detection.
Line coding: Types, Criterions for choosing a line code.
Fiber optics: Elements, Propagation modes.

Module 3: Wireless communication [8 hrs.]
Requirement of modulation.
Analog modulation: AM, FM.
Digital modulation: ASK, PSK, FSK.
Cellular: Architecture, Generations. WiFi.
Satellite: Kepler’s laws, Components of satellite communication.

Module 4: Information theory and coding [8 hrs.]
Information: Definition and measurement, Entropy, Information rate.
Source coding: Huffman coding, Channel coding: Hamming code, Cryptography: RSA algorithm.

Module 5: New frontiers in communication [8 hrs.]
Molecular communication.
In-vivo communication.
Underground communication.
Underwater communication.
V2X communication.
IoT.</td></tr>
</table>

	Module 6: Industrial communication [8 hrs.] Serial communication, Fieldbus, HART.
Text Books, and/or reference material	Text Books: 1. Communication Systems - A. B. Carlson. Reference Books: 1. Communication Systems – S. Haykin. 2. Modern Digital and Analog Communication Systems - B. P. Lathi.

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Programme Outcome) and PSO (Program Specific 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	3	3	2	1	1	1	1	1	1	1	1	1	2	1	1
CO#2	2	3	3	2	1	1	2	1	1	1	1	2	3	3	1
CO#3	3	2	3	2	1	1	2	1	1	1	1	1	1	3	3
CO#4	2	1	1	3	2	3	1	2	1	1	2	1	1	1	2
CO#5	1	1	1	2	1	2	1	1	2	1	2	1	3	1	3
CO#6	1	1	1	1	1	3	2	1	2	2	2	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) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECO540	Mechatronics	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+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 [7L] Signal Conditioning circuits [4L] Digital Processing Elements [2L] 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) 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	PSO1	PSO2	PSO3
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)

<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) / 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>ECE610/ ECO542</td><td>Artificial Intelligence and Soft Computing</td><td>PEL (ECE610) (Open Elective-ECO542)</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) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Objective</td><td colspan="6">The course teaches fundamentals of optimization and different optimization algorithms like Quantum particle swarm optimization, firefly algorithm, teaching learning based optimization algorithm etc. and its applications in engineering/other areas. It also teaches theory and applications of artificial neural network in regression, classification, forecasting etc.</td></tr>
<tr><td>Course Outcomes

After going through the course, student will be able to</td><td colspan="6">On successful completion of this course, students should have the skills and knowledge to:
CO1. Apply soft computing algorithms for solving unconstrained optimization problems.

CO2. Apply soft computing algorithms for solving constrained optimization problems.

CO3. Apply soft computing algorithms for solving different engineering problems.

CO4. Training, testing of multi-layer neural networks in regression, classification, forecasting.

CO5. Determine the center ,groups of data sets using K-means

CO6. Training, testing of Radial Basis Function Neural Networks (RBF) in regression, classification, forecasting.</td></tr>
<tr><td>Topics Covered/ Syllabus</td><td colspan="6">1. Introduction to optimization, Constrained and unconstrained optimization(02 hrs)

2. Single and multi-objective optimization, conventional optimization algorithms such as the method of steepest descent - classical newton's method (02 hrs)

3. Introduction to Optimization based on soft computing , Genetic algorithms, Quantum particle swarm optimization, Firefly algorithm(07 hrs)

4. Flower pollination algorithm,Teaching learning based optimization, Sine cosine algorithm, Gravitational search algorithm(07 hrs)

5. Introduction to artificial neural network, Supervised Learning Neural Networks,</td></tr>
</table>

	Perceptrons, Adaline, Multilayer feed forward neural network, Training of neural network using backpropagation algorithm, Training of neural network using soft computing technique **(08 hrs)** 6. Radial Basis Function Neural Networks(RBF),Training of RBF using pseudo inverse technique **,**Data clustering using K-means**(07hrs)**
Text Books, and/or Reference material	Text Books: 1. Principles of Soft Computing, S N Sivanandam, S. Sumathi, John Wiley & Sons 2. A beginners approach to Soft Computing, Samir Roy & Udit Chakraborty, Pearson 3. Neural Networks: A Classroom Approach,1/e by Kumar Satish, TMH 4. Neural Networks: A Comprehensive Foundation (2nd Edition), Simon Haykin, Prentice Hall.
	Reference Books/materials: 1. S. Rajasekaran and G.A.V.Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI 2. Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, PHI

COURSE ARTICULATION MATRIX

Mapping of CO (Course outcome) and PO (Program Outcome) & PSO (Program Specific 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	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	2	2	2	3	2	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="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) / 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>ECO840</td><td>Communication Network</td><td>PEL (Open Elective)</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="4">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="4">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Identify communication networks suitable for different operational scenarios.
• CO2: Install and troubleshoot typical communication networks.
• CO3: Explain the information flow through various subsystems of a network.
• CO4: Realize the integration between various subsystems of a network.
• CO5: Interpret the current communication technology trends.
• CO6: Evaluate the business potential of future communication networking paradigms.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Module 1: Elements of communication network [2 hrs.]
Network – nodes, links, advantages, evolution path.
Switching – circuit switching, packet switching, store and forward mechanism.

Module 2: Computer networks [8 hrs.]
Computer networks – Ethernet, topology, Ethernet address and IP address.
Interconnecting Ethernets – Hub, Switch, Router.
Layered architectures – Netwrok protocols, TCP/IP, OSI.

Module 3: Landline telephone networks [8 hrs.]
Fundamentals – elements (end nodes, transmission media, switching, signaling), design parameters (GoS, blocking probability, time and call congestion), centralized and distributed switching.
Telephone system – handset, CBS, base unit, transmission impairments, subscriber loop design.

Module 4: Cellular mobile networks [8 hrs.]
Cellular networks – cellular concept, PCS standards (GSM, CDMA), PCS architecture, How a call comes to your mobile phone?
WiFi and Bluetooth.

Module 5: Optical networks [8 hrs.]
FDDI – topology and architecture, access and priority mechanisms, applications.
SONET – topology and architecture, frame format, equipments, deployment and applications.
Under Sea networks – global architecture, how India is served by them?

Module 6: Satellite networks [8 hrs.]
Fundamentals – types of satellites, frequency bands, basic satellite components.
VSAT networks – architecture and applications.
Mobile satellite networks – Iridium, Globalstar.</td></tr>
</table>

Text Books, and/or reference material	Text Books: 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) and PO (Programme Outcome) and PSO (Program Specific 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	3	2	1	2	1	2	1	1	1	1	1	1	3	1	1
CO#2	3	3	3	1	2	1	1	1	2	1	1	1	3	2	1
CO#3	3	2	3	1	1	1	1	1	1	1	1	1	2	2	1
CO#4	2	2	3	3	2	2	2	1	1	1	1	1	1	3	2
CO#5	1	1	2	2	1	3	2	1	1	2	2	1	1	1	3
CO#6	1	1	2	3	1	3	3	2	1	2	3	2	1	1	3

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