Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

B. Tech. (Electronics & Telecommunication Engineering) Syllabus (Semester I-VIII)

2021 Iteration (2021-25)

Department of EXTC

Nomenclature of the Courses

BSC	Basic Science Course	**PC**	Program Core
BSE	Basic Science Elective	**PE**	Program Elective
ESC	Engineering Science Course	**MLC**	Mandatory Learning Course
ESE	Engineering Science Elective	**OE**	Open Elective
SBC	Skilled Based Course	**HSSE**	Humanities and Social Science Elective
ABL-SATVA	Self- Accomplishment Through Various Activities	**SCOPE**	Skill Certification for Outcome based Professional Education
ABL-SEVA	Social Empowerment Through Various Activities		

Abbreviations

L	Lecture Hour	O	Other Work (Self Study)
T	Tutorial Hour	E	Total Engagement in Hours
P	Laboratory Hour	C	Credit Assigned

Engagement and Credit Scheme

Semester I									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	BSC	MA101	Engineering Calculus	3	1	0	8	12	4
2	BSC	AS101	Engineering Physics	2	1	2	5	10	4
3	ESC	AS104	Engineering Graphics	1	0	2	2	05	2
4	ESC	ET101	Basic Electrical Engineering	3	0	2	6	11	4
5	ESC	CS101	Problem Solving using Imperative Programming	2	0	4	4	10	4
6	SBC	AS106	Skill Shop	0	0	2	0	02	1
7	ABL	SV1X/ST1X	SEVA-I or SATVA-I	0	0	0	2	02	1
TOTAL				**11**	**2**	**12**	**27**	**52**	**20**

Semester II									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	BSC	MA102	Differential Equations and Complex Analysis	3	1	0	8	12	4
2	BSC	AS102	Engineering Chemistry	2	0	2	3	07	3
3	BSC	AS103	Biology for Engineers	2	0	0	3	05	2
4	ESC	AS105	Engineering Mechanics	2	0	2	4	08	3
5	ESC	CS102	Problem Solving using OOPs	2	0	4	4	10	4
6	ESC	EC101	Digital Systems and Microprocessors	3	0	2	5	10	4
7	SBC	AS107	Communication Skills	1	0	2	2	05	2
TOTAL				**15**	**1**	**12**	**29**	**57**	**22**

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Semester-I

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Engineering Calculus	3	1	0	8	12	3	1	0	4
		Examination Scheme								
MA101		Component	ISE		MSE		ESE		Total	
		Theory	100		100		200		400	

Pre-requisite Course Codes, if any.	HSC Mathematics
Course Objective: To develop mathematical skills for solving engineering problems.	
Course Outcomes (CO): At *the End of the course students will be able to:-*	
MA101.1	Differentiate a function partially.
MA101.2	Find extreme values of a given function.
MA101.3	Find the nth order derivative of a given function.
MA101.4	Expand a given function as a power series.
MA101.5	Calculate the value of integrals in one variable using different techniques and solve multiple integrals in various coordinate systems.
MA101.6	Calculate Area using double integration.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA101.1	3											
MA101.2	3	1										
MA101.3	2											
MA101.4	2											
MA101.5	3											
MA101.6	2	1										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA101.1							
MA101.2							
MA101.3							
MA101.4							
MA101.5							
MA101.6							

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember √	Understand √	Apply √	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	**Partial Differentiation**	1,2,3	**10**
	1.1	Partial derivatives of first and higher order. Partial derivatives of composite functions.		4
	1.2	Euler's theorem for homogeneous functions with two and three independent variables, deductions from Euler's theorem.		3
	1.3	Application of partial derivatives: i) Local Maxima and Minima of functions of two variables. Ii) Lagrange's Method of undetermined multipliers.		3
2	Title	**Successive Differentiation and Series**	1,2,3	**10**
	2.1	Successive Differentiation: Proofs of nth derivatives of standard functions. Use of De Moivre's theorem and partial fractions to calculate nth derivatives of given functions.		3
	2.2	Leibnitz's Theorem on nth derivative of product of two functions		2
	2.3	Infinite series: 1) Maclaurian's series (without proof) and derivation of series of some standard functions using Maclaurin series. Expansion of functions in powers of x by using i) Standard series method ii) Method of differentiation and integration. 2) Taylor's series and applications.		5
3	Title	**Integral Calculus (one variable)**	1,2,3	**8**
	3.1	Gamma functions: properties of gamma functions and integrals reducible to gamma functions.		2
	3.2	Beta functions: properties, relation between Beta and Gamma functions, integrals reducible to Beta functions, Duplication formula.		4
	3.3	Differentiation under Integral sign: differentiating integrals with constant limits of integration for one parameter.		2
4	Title	**Integral Calculus (multi variable)**	1,2,3	**14**
	4.1	Tracing of curves. Sketching standard solids (Spheres, Ellipsoids, Cylinders, Cones, Tetrahedrons, planes)		2
	4.2	Double Integration: definition and evaluation. Evaluate by changing the order of integration and by changing to polar form.		7
	4.3	Application of double integral to finding area of given regions.		2
	4.4	Triple integration: definition and evaluation (Cartesian and cylindrical coordinates).		3

5	**Self-Study**	1.1 Partial differentiation of implicit functions. 2.3 Series by method of Substitution 3.2 Proof of Duplication Formula 3.3 Differentiation under Integral sign using two parameters and variable limits 4.1 Finding lengths of curves in Cartesian and polar form	1,2,3	**08**
Total				**42***

***Total of 42 hours does not include self-study hours.**

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	**Higher Engineering Mathematics**	**44th**	**Dr. B. S. Grewal**	**Khanna Publications**	**2020**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	**Advanced Engineering Mathematics**	**28th**	**H.K Das**	**S. Chand**	**2014**
2.	**Advanced Engineering Mathematics**	**10th**	**Erwin Kreysizg**	**John Wiley & Sons**	**2011**
3.	**Advanced Engineering Mathematics**	**4th**	**Jain and Iyengar**	**Narosa Publications**	**2014**

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Engineering Physics	2	1	2	5	10	2	1	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
AS101		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	HSC level physics
Course Objective: To provide the knowledge and methodology necessary for solving problems in the field of engineering	
Course Outcomes (CO): At *the End of the course students will be able to*	
AS101.1	Illustrate the knowledge of basic concepts of semiconductor physics, lasers and quantum mechanics.
AS101.2	Solve the problems by applying the basics concepts of physics.
AS101.3	Use the Schrodinger equation to realize the concept of discreteness and quantum tunneling.
AS101.4	Explain the working of various LASERs and its practical applications.
AS101.5	To develop experimental skills and the practical abilities.
AS101.6	To develop an ability of understanding of concepts and principles of physics.
AS101.7	To comprehend importance of precision, accuracy of the experimental data.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS101.1	1											
AS101.2		1										
AS101.3		1										
AS101.4	1											
AS101.5				1								
AS101.6				1								
AS101.7												

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS101.1							
AS101.2							
AS101.3							
AS101.4							
AS101.5							
AS101.6							
AS101.7							

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Quantum Mechanics**		09
	1.1	De-Broglie hypothesis; experimental verification of de Broglie hypothesis; wave packet, group velocity and phase velocity; Wave function, Physical interpretation of wave function; Heisenberg's uncertainty principle; Electron diffraction experiment; Applications of uncertainty principle	1,2,3	
	1.2	Schrodinger's time dependent wave equation, time independent wave equation; Application of time-independent Schrodinger equation – Particle trapped in one dimensional box and Potential barrier (Tunnelling), Harmonic oscillator (qualitative)	1,2,3	
2	Title	**Physics of Semiconductors and Semiconductor devices**		13
	2.1	Conduction in metals and semiconductors; Fermi-Dirac distribution function and Fermi level in a conductor, insulator and semiconductor	5	
	2.2	Intrinsic and extrinsic semiconductors; intrinsic conductivity and extrinsic conductivity; Law of mass action, charge neutrality condition; intrinsic carrier concentration, electron and hole concentration; Extrinsic carrier concentration as a function of temperature; Effect of impurity concentration and temperature on the Fermi Level; Hall Effect and its applications. Drift and Diffusion current density	5	
	2.3	Formation of a P-N junction, depletion region and barrier potential; Energy band structure of P-N Junction (unbiased, forward-bias, reverse-bias); concept of carrier current densities in p-n junction in equilibrium, forward bias and reverse bias; Breakdown mechanism – Zener effect and avalanche	5,6	
	2.4	P-N junction devices: LED, Zener diode, photoconductors, photovoltaic solar cells and Bipolar Junction Transistors	5,6	
3	Title	**LASERS**		06
	3.1	Processes – Absorption of light, spontaneous emission, stimulated emission; Einstein's equations, Population inversion; metastable states; pumping and pumping schemes; optical resonance cavity	3,4	
	3.2	Ruby and Helium Neon laser, semiconductor laser; Applications of laser in industry, medicine, and holography. (construction & reconstruction of holograms)	3,4	

4	**Self-Study**	Interference of light in thin films having uniform thickness, Newton's rings, Applications of interference in anti-reflecting and highly reflecting thin films. Diffraction of light, Diffraction due to single slit, double slit, and diffraction grating.		**05***
			Total (*Not included)	**28**

Laboratory Component

Sr. No.	Title of the Experiment*
1	Determination of energy band gap of a semiconductor
2	Study of I-V characteristics of a Zener diode
3	Determination of the type of semiconductor sample, concentration of charge carriers and its mobility using Hall Effect
4	Determination of Planck's constant using photo vacuum tube
5	Measurement of ultrasonic velocity in liquid medium using ultrasonic interferometer
6	Determination of radius of curvature using Newton's Rings
7	Determination of thickness of a thin foil or wire using the interference pattern of a wedge-shaped film
8	Determination of wavelengths of a mercury source and resolving power of a plane diffraction grating
9	Study of single slit diffraction
10	Determination of grating element of a diffraction grating using a laser source
11	Determination of the numerical aperture of an optical fibre
12	Uses of a Cathode-Ray Oscilloscope

*Students will perform any 10 of the above experiments

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	A Textbook of Engineering Physics	11	Dr. M.N. Avadhanulu & Dr. P. G. Kshirsagar	S. Chand	2018
2.	Engineering Physics	1	D. K. Bhttacharya & Poonam Tandon	Oxford University Press	2015

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	Concepts of Modern Physics	6	Arthur Beiser	McGraw Hill Education	2009
2.	Modern Physics	3	Serway, Moses and Moyer	Thomson Learning	2005

3.	Fundamentals of Physics	10	Halliday and Resnick	Wiley	2013
4.	Solid State Physics	8	S. O. Pillai	New Age International Publishers	2018
5.	Solid State Electronic Devices	7	Ben G. Streetman and Sanjay Kumar Banerjee	Pearson Education	2016
6.	Lasers: Fundamentals and Applications	2	Ghatak and Thyagarajan	Springer	2011

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(ESC)	Engineering Graphics	1	0	2	2	5	1	0	1	2
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
AS104		Theory		20		20		60		100
		Laboratory		60		--		40		100

Pre-requisite Course Codes, if any.	Fundamentals up to 12th science
Course Objective: To develop technical drawing and visualization skills using instrumental drawing and soft tool, required for design and modeling, in Engineering Applications and Solutions.	
Course Outcomes (CO): *At the End of the course students will be able to*	
AS104.1	Construct basic engineering curves.
AS104.2	Draw projections of points and lines.
AS104.3	Draw projections of regular solids inclined to both the reference planes.
AS104.4	Read the 3-dimensional view and draw the orthographic projections.
AS104.5	Read the 3-dimensional view and draw the sectional orthographic projections.
AS104.6	Read the orthographic projections and draw isometric view.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS104.1	3	3										3
AS104.2	3	3										3
AS104.3	3	3										3
AS104.4	3	3										3
AS104.5	3	3										3
AS104.6	3	3										3

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Unit1	**Introduction to Engineering Drawing**	1,2	4
	1.1	Introduction to Drawing Instruments, Types of Lines, Dimensioning Systems and Scaling as per IS conventions. First angle method of projection only		
	1.2	Basic construction of Cycloid and Involutes.		
2	Unit2	**Projections of Points and Lines**	1	4
	2.1	Projection of points in all four quadrants		
	2.2	Projection of lines parallel to one principal reference plane.		
	2.3	Lines inclined to both the Reference Planes (Excluding Traces of lines).		
3	Unit3	**Projections of solids** (Regular solids like Prism, Pyramid, Cylinder, Tetrahedron, Hexahedron and Cone only)	1,2	7
	3.1	Projection of solid resting on plane (Single step projection)		
	3.2	Projection of solid such that base inclined to one reference plane (Two step projection)		
	3.3	Projection of solid such that base inclined to both reference planes (Three step projection/problem) (Exclude Spheres, Composite, Hollow solids and frustum of solids)		
4	Unit4	**Orthographic Projections**	1,2	**Lab Sessions**
	4.1	Orthographic views of a simple machine part as per the first angle method of projection recommended by I.S.		
	4.2	Full Sectional views of the Simple Machine parts.		
5	Unit5	**Isometric Projections and views**	2	**Lab Sessions**
	5.1	Isometric views (Natural scale only)		
6	**Self Study**	1.2 Construction of Engineering curves like ellipse, parabola, hyperbola, helix, other types of cycloids etc. by using different method of construction. 2.1 Projection of lines with traces, application-based problems on Projection of lines 3.1 Projections of cut solids with different cutting planes. 4.1 Solve more practice examples of orthographic views. Draw different views of a machine part/any object using third angle method of projection. (Axonometric view, oblique view, perspective etc.)	1,2, 3	**6***

		4.2 Half sectional orthographic views. 5.1 Development of surfaces of frustum of solid, and retaining part of the solid after cutting plane, reverse development of solid.		
Total (*Not included)				**15**

Laboratory Component (Minimum 5 sheets are expected)

Sr. No	**Noof Sessions**	**Engineering AutoCAD Laboratory**
1	**2**	Introduction to Auto-CAD: -Basic Draw and Modify Commands. Knowledge of setting up layers, Dimensioning, Hatching, plotting, and Printing. **Auto-Cad Practice sheet-1**
2	**1**	**Auto-Cad Practice sheet-2**
3	**2**	**Introduction to Orthographic projections sheet 3**
4	**2**	**Orthographic projections sheet 4**
5	**2**	**Introduction to Sectional Orthographic projections sheet 5**
6	**2**	**Sectional Orthographic projections sheet 6**
7	**2**	**Introduction to Isometric Projection/View: -** Isometric View of blocks with plain and cylindrical surfaces is using plain/natural scale only. (Exclude Spherical surfaces). **Isometric Projection/View sheet 7**
8	**2**	**Isometric Projection/View sheet 8**
Total	**15**	

Textbooks:

Sr. No	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
1	Engineering Drawing	53rd	N D Bhatt	Charotar	2016
2	Engineering Drawing	3rd	Dhananjay A Jolhe	Tata McGraw Hill	2011

Reference Books

Sr. No	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
1	AutoCAD 2017	--	Sham Tickoo	DreamTech Press, Delhi	2017
2	Engineering Drawing and Graphics	Fifth	K Venugopal	New Age International	2011

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(ESC)	Basic Electrical Engineering	3	0	2	6	11	3	0	1	4
		Examination Scheme								
ET101		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	Basic concepts of electric charge, current, voltage and Power
Course Objective: To impart a basic knowledge of electrical quantities, circuits and components.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
ET101.1	Compute various electrical quantities of given dc circuit using circuit simplification techniques and various network theorems.
ET101.2	To expose the students to different terms and concepts in AC Circuits at fundamental frequency and to expose them to basics of effects of harmonics in the waveforms
ET101.3	To study the working principles of electrical machines and their applications
ET101.4	To expose the students the fundamental concepts in Controllable Switch and Modulation based Power Conversion
ET101.5	To study Electrical Parameters of the Batteries and their selection and design criteria for a specific application

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET101.1	3	2			3							
ET101.2	3	2			3							
ET101.3	3				3							
ET101.4	3				3							
ET101.5	3				3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET101.1					3	3	
ET101.2					3	3	
ET101.3							
ET101.4							
ET101.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**DC Circuits**		10
	1.1	Electrical circuit elements (R, L and C), Voltage and current sources, Equivalent resistance of circuits, Simplification using delta-star and star-delta transformation.		
	1.2	Kirchhoff's current and voltage laws, Analysis of simple circuits with dc excitation. Mesh analysis, Superposition, Thevenin, Norton and Maximum Power Transfer Theorems		
	1.3	Time-domain analysis of first-order DC Transients in RL and RC circuits.		
2	Title	**AC Circuits**		12
	2.1	Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Harmonics, Total Harmonic Distortion, Power supplied by Harmonic voltages and currents, Power factor in case of non-sinusoidal waveforms.		
	2.2	AC Analysis of series and parallel RLC Circuits with Resonance, Concept of Bandwidth and Q-factor,		
	2.3	Three-phase balanced circuits, voltage and current relations in star and delta connections.		
3	Title	**Electromagnetic and Electro-Mechanical Energy Converters**		10
	3.1	Magnetically Coupled Coils, Self and Mutual Inductance and Dot Convention		
	3.2	Single Phase Transformer: Principle of Operation, Equivalent Circuits, Efficiency and Regulation.		
	3.3	Introduction to Three-phase Transformers and Applications		
	3.4	Fundamental Principles of Rotating Machines, Characteristics of Induction motor and DC motor		
4	Title	**Electric Power Converters**		05
	4.1	Fundamental Principles of Buck, Boost and buck-boost DC-DC converters and their Transfer Characteristics, Duty Ratio Control		
	4.2	Single-phase voltage source inverters and PWM		
5	Title	**Batteries: Electrical Characteristics and Applications**		05
	5.1	Introduction to type of Batteries, Generalized Battery parameters such as SoC, DoD, Energy and Power Densities, Battery C-rating, etc. Comparison of Batteries, Charging and Discharging Characteristic		
	5.2	Selection and Sizing of Battery Packs for Specific Applications		
6	Self-Study	Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Elementary calculations for energy consumption and power factor improvement.		3*
			Total (*Not included)	42

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
01	Introduction to Electrical Measuring instruments, Lamp Loads, Inductor Loads and Capacitor Bank
02	Verification of Star-Delta and Delta-star Transformation with Kirchoff's Laws
03	Verification of Thevenin's Norton's and Maximum Power Transfer Theorem
04	Verification of DC Transient equations in RL and RC Circuits
05	Experimental study of single-phase AC circuit with R-L and R-C Load with Measurement of Power and Power factor
06	Experimental study of R-L-C Series Resonance. To plot resonance curve, To compute Bandwidth and Q-factor
07	Experiment on Magnetic Circuit Fundamentals
08	Loading of a transformer: measurement of primary and secondary voltages and currents, and power. To compute efficiency and regulation.
09	Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
10	Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super-synchronous speed.
11	Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform.
12	Demonstration of V/F control of Induction motor
13	Experimental study of charge and Discharge characteristics of a Lead-acid Battery
14	Introduction to L.T. Switch gear

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Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Basic Electrical Engineering	**3rd**	D. P. Kothari and I. J.	Tata McGraw Hill	2010
2	Electrical Technology	23rd	B. L. Theraja	S. Chand Publications	2003

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
01	Basic Electrical Engineering	2nd	D. C. Kulshreshtha	McGraw Hill	2019
02	Fundamentals of Electrical Engineering	2nd	L. S. Bobrow	Oxford University Press	2011
03	Electrical and Electronics Technology	3rd	E. Hughes	Pearson	2010
04	Electrical Engineering Fundamentals	2nd	V. D. Toro	Prentice Hall India	1989
05	Elements of Power Electronics	2nd	P. T. Krein	New York and Oxford: Oxford University Press	2015
06	Power Electronics: Converters, Application and Design	2nd	Ned Mohan, T.M Undelands and W P Robbins	John Wiley and Sons. Inc.	1995
07	Electric Machinery	6th	A. E. Fitzgerald, C. Kingsley and S. D. Umans	McGraw-Hill	2003

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(ESC)	Problem Solving using Imperative Programming	2	0	4	4	10	2	0	2	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS101		Theory	-		-		-			-
		Laboratory	300		--		100			400

Pre-requisite Course Codes, if any.	
Course Objective: To develop problem solving skills using imperative programming	
Course Outcomes (CO): ***At the End of the course students will be able to***	
CS101.1	Explain the problem-solving aspects using various programming paradigms.
CS101.2	Solve real world problems using imperative programming approach.
CS101.3	Solve problems using control structures for real world problems.
CS101.4	Solve problems using Arrays and Text processing.
CS101.5	Develop modular code for a given problem.
CS101.6	Solve real world problems using Structures and Unions

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS101.1	1											
CS101.2	2	2										
CS101.3	2	2										
CS101.4	2	2										
CS101.5	2	2										
CS101.6	2	2										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS101.1							
CS101.2							
CS101.3							
CS101.4							
CS101.5							
CS101.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply √	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Problem Solving and Programming Paradigms**		
	1.1	What is a Problem, Problem Solving Aspect, Top-Down Design, Implementation of Algorithms, Characteristics of a good algorithm, what is a computer program, real life examples of programming, Computer based applications of programming, Steps followed in Program Development, Characteristics of good Program	3,4	2
	1.2	Overview of Programming Paradigms - Declarative and Imperative, Problem-solving using Algorithm and Flowcharts,	3,4	2
2	**Title**	**Basic Elements of Computer Programming and Control flow**		
	2.1	Variables, keywords, Data types, Operators**:** Arithmetic, Relational and Logical, Assignment, Unary, Conditional, Bitwise, Expression, Statements.	1,2	1
	2.2	Branching Structures: if statement, if-else statement, multi-way decision, switch statement, continue statement, break statement Iterative Structures: while, do-while, for, nested loops	1,2	3
	2.3	Problem solving using Control Structures for real world problems	1,2,4	2
3	**Title**	**Problem Solving using Array Techniques**		
	3.1	Introduction to Arrays: Declaration, Definition, accessing array elements, one-dimensional array, two-dimensional array, array of characters, Strings	1,2	2
	3.2	Classical Problem-Solving using Arrays like Array Order Reversal, Array Counting or Histogramming, Finding the maximum number in a set.	1,2,4	2
	3.3	Text Processing problems like finding length, keyword search, finding anagrams	1,2,4	2
4	**Title**	**Problem Solving using Modular Approach**		
	4.1	Defining a Function, accessing a Function, Function Prototype, Passing Arguments to a Function, call by value, pointers and call by reference, Recursion	1,2	4
	4.2	Problem solving using Functions and Recursive applications	1,2,4	3
5	**Title**	**Structures and Unions**		
	5.1	Structures and Union: Declaration, Initialization, structure within structure, Array of Structure, Operation on structures, Concept of Union, Difference between structure and union,	1,2	3
	5.2	Real world problems using Structures and Unions	1,2,4	2
6	**Self Study**	File handling**:** Types of Files, File operation- Opening, Closing, Creating, Reading, Processing File, Command line arguments, Dynamic Memory Allocation	1,2,4	**4***
			Total (*Not included)	**28**

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Department of EXTC

Note: All problems should be implemented using C language.

Sr. No.	Title of the Experiment
1	Use the formatted input/output statements, operators and expressions of C language
2	Apply various control structures to solve given problems.
3	Apply the concept of functions to incorporate modularity.
4	Demonstrate the use of one-dimensional arrays to solve a given problem.
5	Demonstrate the use of two-dimensional arrays to solve a given problem.
6	Apply the concept of recursion to solve a given problem.
7	Implement various text processing problems.
8	Apply the concepts of structures/union to solve a given problem.
9	Demonstrate the use of pointers to solve a given problem.
10	Implement various operations on files to solve a given problem.

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Programming with C	Fourth	Byron Gottfried	McGraw Hill (Schaum's outline series)	2018
2	The C programming Language	Second	Kernighan , Ritchie	Pearson	2015
3	Foundations of Programming Languages	Second	Kent D. Lee	Springer	2017
4	How to Solve it by Computer	First	R. G. Dromey	Prentice Hall India	1998

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Let Us C	Sixteenth	Yashavant Kanetkar	BPB	2017
2	Programming Language Concepts	Third	Carlo Ghezi, Mehdi Jazayeri	John Wiley & Sons	2008
3	Computer Programming in C	Second	V. Rajaraman & Neeharika Adabala	PHI Learning, Eastern Economy Edition,	2014

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Skill Shop	0	0	2	0	02	0	0	1	1
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
AS106		Theory	--		--		--			--
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To equip the students with the fundamental skills involved in the creation of simulated and physical design.	
Course Outcomes (CO): At *the End of the course students will be able to*	
AS106.1	Operate basic electronic equipment and instruments.
AS106.2	Make PCB designs in simulations.
AS106.3	Assemble, disassemble, and troubleshoot computer hardware and network peripherals.
AS106.4	Fabricate basic jobs in traditional trades.
AS106.5	Design a 3D model and translate it to a 3D printed component.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS106.1									3			3
AS106.2			3		3				3			
AS106.3									3			3
AS106.4									3			3
AS106.5					3				3			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS106.1	3						
AS106.2	3						
AS106.3	3						
AS106.4	3						
AS106.5	3						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Department of EXTC

Lab Component

Trade No.	Unit No.	Topics	Ref.	Hrs.
1	Unit 1	**Electronic Components**	5	4
	1.1	**Introduction to Electronic Components** Exposure to usual electronic equipment/instruments such as Multi-meter, Oscilloscope, Function generator, IC tester and Power supply, Information about their front panels, Demonstrations on their working, Hands-on for measurement of component values and DC voltage using multi-meter, AC mains voltage/1 KHz Square wave/any small signal from function generator on Oscilloscope, Testing of sample digital ICs using IC tester. **OR** **Repairing of gadgets and appliances:** Elementary skills of repairing juicer, mixer, grinder, etc.		
2	Unit 2	**PCB Laboratory Exercises**	6	4
	2.1	Layout drawing, Positive and negative film making, PCB etching and drilling, Tinning and soldering technique.		
3	Unit 3	**Hardware and Networking**	7, 8	4
	3.1	Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc.		
	3.2	Assembling of PC, Installation of Operating System and Device drivers, Boot-up sequence. Installation of application software (at least one).		
	3.3	Basic troubleshooting and maintenance.		
	3.4	Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping.		
4	Unit 4	**Traditional Trades***	1, 2	4
		Carpentry Use and setting of hard tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood turning and modern wood turning methods. One carpentry job involving a joint and report on demonstration of a job involving wood turning required for successful completion of module. OR **Electrical board wiring** House wiring, staircase wiring, and wiring diagram for fluorescent tube light, Godown wiring and three phase wiring for electrical motors. OR **Sheet Metal Practice**		

		Introduction to primary technology processes involving bending, punching and drawing various sheet metal joints, development of joints. Utility job in sheet metal required for successful completion of module.		
5	**Unit 5**	**3D Modeling and Printing**	3, 4	**4**
	5.1	Modeling approaches for ideation and creation. Developing a CAD file (.iges/.step/.dwg) of a 3D model and export it as an .stl file for the purpose of 3D printing. Importing the 3D .stl file to generate a .gcode file for 3D printing through slicing, using open source software.		
	5.2	Introduction to 3D printing: methodologies, best practices, material and model variation. Live printing sessions of generated .gcode files in real time with optimal parameters and troubleshooting.		
			Total	**20**

*** Students can opt for any one of the three trades from Unit 4.**

Textbooks:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Workshop Manual	6th	Venkat Reddy	BS Publication	2008
2	Wiring Simplified: Based on 2017 National Electrical Code	45th	Frederic P Hartwell, Herbert P. Richter, W. C. Schwan	Park Publishing	2017

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
3	Autocad 2017	1st	Shyam Tikoo	Dreamtech Press	2016
4	Ultimaker 2+ reference manual	-	-	Ultimaker	2017
5	Encyclopedia of Electronic Components	1st	Charles Platt	O Reilly	2012
6	Printed Circuit Boards	1st	Khandpur R. S.	Tata McGraw Hill	2005
7	Troubleshooting Your PC For Dummies	2nd	Gookin Dan	For Dummies	2005
8	Networking For Dummies	8th	Lowe Doug	For Dummies	2007

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

Semester-II

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Differential Equations and Complex Analysis	3	1	0	8	12	3	1	0	4
MA102		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	100		100		200			400

Pre-requisite Course Codes, if any.	Semester-I Mathematics
Course Objective: To develop mathematical skills for solving engineering problems.	
Course Outcomes (CO): At *the End of the course students will be able to:-*	
MA102.1	Solve differential equations of first order.
MA102.2	Solve differential equations of higher order using operators.
MA102.3	Solve differential equations in electrical engineering problems.
MA102.4	Find powers, roots & logarithm of a complex number and to separate the function of a complex number into real and imaginary.
MA102.5	Check whether a given function is analytic and construct analytic functions.
MA102.6	Compute integrals of complex valued functions.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA102.1	3											
MA102.2	3											
MA102.3	1	1										
MA102.4	3											
MA102.5	2											
MA102.6	2	1										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA102.1							
MA102.2							
MA102.3							
MA102.4							
MA102.5							
MA102.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	**Understand√**	**Apply√**	**Analyze**	**Evaluate**	**Create**

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	**Linear Differential Equations of first order**	1,2,3	**11**
	1.1	Exact Differential Equations, Integrating Factors, equations reducible to exact form.		3
	1.2	Linear differential equations (Definition), equations reducible to linear form, Bernoulli's equation		2
	1.3	Simple application of differential equation of first and second order to electrical engineering problems.		2
	1.4	Numerical solution of ordinary differential equations of first order and first degree using (a)Taylor's series method (b)Euler's method (c) Modified Euler method (d) Runge-Kutta fourth order formula.		4
2	Title	**Linear Differential Equations of higher order**	1,2,3	**11**
	2.1	Linear Differential Equation with constant coefficient- complementary function, particular integrals of differential equation of the type f(D)y = X where X is e^{ax}, sin(ax+b), cos(ax+b), x^m, e^{ax}V, xV, where V is a function of x.		7
	2.2	Cauchy's homogeneous linear differential equation and Method of variation of parameters for second order.		2
	2.3	System of Differential Equations.		2
3	Title	**Complex Numbers**	1,2,3	**12**
	3.1	**Revision:** Complex Numbers as ordered pairs, Argand's diagram, Cartesian, Polar and Exponential form of Complex Numbers.		1
	3.2	De Moivre's Theorem and its application to determine powers of complex numbers. Roots of complex numbers by De Moivre's Theorem.		3
	3.3	Expansion of $\sin n\theta$ and $\cos n\theta$ in terms of powers of $\sin\theta$ and $\cos\theta$. Expansion of $sin^n\theta$ and $cos^n\theta$ in terms of sines and cosines of multiples of θ.		2
	3.4	Hyperbolic Functions: relation between circular and hyperbolic functions, Inverse hyperbolic functions. Separation into real and imaginary parts of complex functions.		4
	3.5	Logarithm of a complex number.		2
4	Title	**Analytic functions and Complex Integrals**	1,2,3	**8**
	4.1	Analytic functions, Cauchy Reimann equations in cartesian and polar form, construction of analytic functions using Milne-Thompson's method, Harmonic functions, poles of f(z).		4
	4.2	Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula (for poles lying inside or outside the curve).		4

5	**Self-Study**	1.3 To form D.E. for given L-C-E-R circuit 1.4 Picard's method 2.1 Method of undetermined coefficients to solve differential equations. 2.2 Legendre's differential equation, Method of variation of parameters for third order differential equations. 3.2 Complex examples using De Moivre's Theorem. 4.1 Construction of analytic function f(z) =u+iv when u+v or u-v is given. Orthogonal trajectories		**08**
			Total	**42***

***Total of 42 hours does not include self-study hours.**

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	**Higher Engineering Mathematics**	**44th**	**Dr. B. S. Grewal**	**Khanna Publications**	**2020**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	**Advanced Engineering Mathematics**	**28th**	**H. K Das**	**S. Chand**	**2014**
2.	**Advanced Engineering Mathematics**	**10th**	**Erwin Kreysizg**	**John Wiley & Sons**	**2011**
3.	**Advanced Engineering Mathematic**	**4th**	**Jain and Iyengar**	**Narosa Publications**	**2014**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Engineering Chemistry	2	0	2	3	7	2	0	1	3
AS102		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	HSC level Chemistry
Course Objective: To provide necessary background of Chemistry suited for relevant areas of engineering	
Course Outcomes (CO): At *the End of the course students will be able to*	
AS102.1	Relate thermodynamic principles and laws to crucial applications like heat engines (Understanding)
AS102.2	Summarize properties and applications of different materials like polymers, ceramics, alloys, nanomaterials, conductors, and insulators (Understanding)
AS102.3	Identify methods for corrosion control based on knowledge of different types of corrosion and factors affecting rate of corrosion (Application)
AS102.4	Compare different sources of energy like conventional fossil fuels, alternative fuels, batteries, and fuel cells with respect to availability, working principles, constitution, efficiency of performance and environmental impact (Understanding)
AS102.5	Apply knowledge of electrochemistry and green chemistry in the interest of public health and environment (Application)
AS102.6	Make use of analytical techniques (complexometric and iodometric titrations) and instruments (pH-meter, conductometer and Orsats's Apparatus) for various purposes like hardness parameters of water, composition of alloys etc.
AS102.7	Estimate key properties of lubricants like flash point, viscosity and acid value
AS102.8	Estimate molecular weight of polymer

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS102.1	1											
AS102.2	1											
AS102.3	2											
AS102.4	2						1					
AS102.5	1						2					
AS102.6				1								
AS102.7				1								
AS102.8				1								

Department of EXTC

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS102.1							
AS102.2							
AS102.3							
AS102.4							
AS102.5							
AS102.6							
AS102.7							
AS102.8							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Thermodynamics**		4
	1.1	Introduction, Terminology, Concepts of Internal Energy and Thermodynamic equilibrium, Zeroth and First Law of Thermodynamics, Implications and Limitations of First law	1,3	
	1.2	Concept of Enthalpy, Joule Thomson Effect, Carnot's Cycle, Carnot's theorem and related numerical, Second Law of Thermodynamics	1,3	
	1.3	Applications of thermodynamic principles to the working of refrigerator and air conditioner	1,3	
2	Title	**Polymers**		3
	2.1	Introduction, Effect of heat on polymers: Glass transition temperature and melting with significance;	1, 2, 3	
	2.2	Conducting polymers, Liquid crystal polymers, Engineering Polymers	1, 2 ,3	
3	Title	**Corrosion**		5
	3.1	Introduction, Dry corrosion(i) Due to oxygen (ii) Due to other gases	1,2	
	3.2	Electrochemical corrosion and mechanism, Galvanic, differential aeration corrosion, Significance of galvanic series for corrosion phenomenon	1,2	
	3.3	Factors affecting rate of corrosion (i)Position in galvanic series, (ii) relative areas of anode and cathode, (iii) conductance of medium	1,2	
	3.4	Methods to decrease the rate of corrosion: Material selection, Proper designing, Cathodic protection- i) Sacrificial anodic protection	1,2	

		ii) Impressed current method, Metallic coatings, Cathodic and anodic coatings (Galvanization and Tinning: principle and application only)		
4	**Title**	**Energy Sciences**		5
	4.1	Definition and classification of fuels, Calorific value: Definition, Gross or Higher calorific value & Net or lower calorific value, Dulong's formula & numerical for calculations of Gross and Net calorific values.	1,2	
	4.2	Knocking, Octane number, Cetane number, Antiknock agents, unleaded petrol	1,2	
	4.3	Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels.	1,2	
	4.4	Disadvantages of fossil fuels, Alternative (Green) Fuels: Power alcohol, Biomass, Biogas, Biodiesel, Natural Gas and CNG (Description, Utility, advantages, and disadvantages)	1,2	
5	**Title**	**Batteries and Battery Technology**		4
	5.1	Introduction, Important terms, Nickel-Hydrogen (metal hydride), Rechargeable Lithium-ion batteries	1,2	
	5.2	Reserve Batteries, Fuel cells, characteristics, description, construction and working of Hydrogen-oxygen fuel cells, Types of fuel cells (in brief)	1,2	
	5.3	Electrochemical sensors: Working principle, construction and applications	1,2	
6	**Title**	**Green Chemistry**		
	6.1	12 principles of green chemistry with examples, numericals on Atom Economy, Green Solvents (Water, Supercritical Fluids),	1,2	3
7	**Title**	**Engineering Materials**		
	7.1	Eutectic mixtures and soft solders, Advanced Ceramic materials and cermets : magnetic, electronic and electrical applications Carbon nanomaterials: Fullerenes and Carbon nanotubes, Structure, Properties and applications	1,2,3	4
	7.2	Insulators, Semiconductors and Superconductors: Thermal and electrical insulating materials and important engineering applications, Stoichiometric, defect and controlled valency semi-conductors.	1,2,3	
	7.3	Superconductors, perovskite structure and 1:2:3 compound YBa2Cu3O7-y, properties and applications	1,2,3	
8	**Self-Study**	1. Supramolecular polymers and their applications 2. Anodic Protection as a corrosion control strategy 3. Current research and advances in fuel cells 4. Commercial applications of superconducting materials 5. Tops down vs bottoms up approach to nanotechnology and applications of nanoparticles other than carbon		4*
			Total (*Not included)	**28**

Laboratory Component

Sr. No.	Title of the Experiment
1	Determination of total, temporary and permanent hardness of water sample
2	Removal of hardness using ion exchange column
3	Molecular weight determination of polymers by Oswald's Viscometer
4	To determine flash point of a lubricating oil
5	Determination of Viscosity of oil by Redwood Viscometer
6	Estimation of acid value of lubricant
7	Determination of amount of strong acid present in a solution using a conductometer
8	Determination of strength of acid using a pH meter
9	Estimation of Copper in brass by Iodometric Titration
10	Analysis of Flue gas for its composition (by Orsat's Apparatus)
11	Estimation of Iron in plain Carbon steel
12	Determination of COD of wastewater sample

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	**Engineering Chemistry**	**XI**	**P. C. Jain & M. Jain**	**Dhanpat Rai & Co. (Pvt) Ltd.**	**2014**
2	**A Textbook of Engineering Chemistry**	**XII**	**S. S. Dara & S. S. Umare**	**S. Chand & Co.**	**2014**
3	**A Textbook of Engineering Chemistry**	**III**	**S Chawla**	**Dhanpat Rai & Co. (Pvt) Ltd.**	**2015**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	**Physical Chemistry**	**Eleventh**	**Peter Atkins**	**Oxford University Press**	**2017**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Biology for Engineers	2	0	0	3	5	2	0	0	2
AS103		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	-		--		-			-

Pre-requisite Course Codes, if any.	HSC level Biology
Course Objective: To provide engineering perspective towards the biological principles and systems	
Course Outcomes (CO): At *the End of the course students will be able to*	
AS103.1	Understand basic biological principles and organizational structure of living systems at molecular level.
AS103.2	Comprehend basic biological principles and organizational structure of living systems at cellular level
AS103.3	Know Energy transformation and information processing in biological systems
AS103.4	Appreciate biological process with engineering perspective
AS103.5	Identify significance of Gene, Blood and Skin in human health system.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS103.1	3											
AS103.2	3											
AS103.3	2											
AS103.4	2	1										
AS103.5	2	1										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS103.1							
AS103.2							
AS103.3							
AS103.4							
AS103.5		2					

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	**Understand√**	**Apply√**	**Analyze**	**Evaluate**	**Create**

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Biomolecules and bio-polymers:** Structure and Function	1,3	4
	1.1	Organic and inorganic molecules, Unique Properties of water		
	1.2	Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA)		
2	**Title**	**Levels of organization of life**	1,3	4
	2.1	Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane.		
	2.2	**Levels of organization:** cells, tissues, organs, systems & organism		
3	**Title**	**Energy transformations**	1,3	5
	3.1	**Energy transformations in Chloroplast:** Photosynthesis (photochemical & biochemical phase) and ATP generation, Aerobic and anaerobic systems		
	3.2	**Energy transformations in Mitochondria:** Cellular respiration (glycolysis and Kreb cycle) and ATP generation		
4	**Title**	**Transport and Defense mechanisms**	1,3	5
	5.1	**Transport Phenomena in Biological Systems:** Membrane channels and ion channels; Fluid flow and mass transfer (nutrients & ions); In plants: Xylem and Phloem; In animals: Blood and Lymph Transport of gases: Oxygen and Carbon dioxide Heat Transport - Body temperature regulation.		
	5.2	**Defense mechanisms:** In plants: Herbivory, secondary metabolites In animals: Innate and Adaptive immune systems		
5	**Title**	**Engineering perspectives of biological sciences:**	1,3	
	6.1	Biology and engineering crosstalk – At cell level: Hybridoma technology At tissue level: Plant Tissue Culture, Animal Tissue Culture;		6
	6.2	Tissue Engineering: Principles, methods and applications Introduction to Biomimetics and Biomimicry, nano-biotechnology		
6	**Title**	**Role of Gene, Blood and Skin in human health system.**	2,4	4
	7.1	Introduction to Genetic Engineering. Blood Type, Complete Blood Count Test and Abnormalities.		
	7.2	Structure of Skin, Functions of Skin. Engineering methods for identification of Skin diseases.		
7	**Self Study**	Introduction to Biosensors, transducers, amplifiers; Introduction to medical imaging and different medical Imaging modalities; Review of Signals and system; Electro Physiological Signal Analysis.		**4***
			Total (* Not included)	**28**

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Molecular Cell Biology	IV	Lodish H, Berk A, Zipursky SL	W. H. Freeman	2000
2	Textbook of Anatomy and Physiology for Nurses and allied Health Sciences	I	Indu Khurana & Arushi	CBS Publsihers & Distributors Pvt Ltd	2019

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
3	Lehninger Principles of Biochemistry	IV	Nelson, D. L., & Cox, M. M.	Freeman	2004
4	Introduction to Biomedical Engineering.	III	Joseph D. Bronzino, John Enderle	Academic Press	2012

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(ESC)	Engineering Mechanics	2	0	2	4	08	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
AS105		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To provide knowledge of force analysis methods required in engineering applications and solutions. Also, to develop analytical and computational ability.	
Course Outcomes (CO): At *the End of the course students will be able to*	
AS105.1	Draw free body diagram and determine reactive forces using conditions of equilibrium and Lami's theorem
AS105.2	Determine coefficient of friction for various contact surfaces
AS105.3	Analyze the three-dimensional system of space forces.
AS105.4	Analyze the kinematics of particle and obtain the various parameters of motion.
AS105.5	Determine Instantaneous center of rotation (ICR).
AS105.6	Design and conduct an experiment to demonstrate principles of statics and dynamics

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS105.1	3	3										
AS105.2	3	3										
AS105.3	3	3										
AS105.4	3	3										
AS105.5	3	3										
AS105.6	3	3							3			

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS105.1	3						
AS105.2	3						
AS105.3	3						
AS105.4	3						
AS105.5	3						
AS105.6	3						

Department of EXTC

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Equilibrium of forces**		8
	1.1	Equilibrant force, conditions of equilibrium for concurrent forces, parallel forces and general force system, equilibrium of connected bodies, Lami's theorem.	1,3	
	1.2	Types of supports, types of loads, Beams, Determination of reactions at supports for various types of loads on beams	3	
2	Title	**Friction**		4
	2.1	Introduction to Laws of friction, Cone of friction, Equilibrium of bodies on inclined plane, Application to problems involving wedges, ladders.	1,2	
3	Title	**Forces in space**		5
	3.1	Rectangular Components of Forces in Space, Resultant of Space forces, Moment of a Force about a point, axis and line. Equilibrium of a particle in space.	1	
4	Title	**Kinematics of Particle**		8
	4.1	Motion along straight and curved path, Rectangular component of velocity and acceleration, Tangential & Normal component of acceleration, Motion curves(a-t, v-t, s-t curves), Projectile motion,	2,3	
5	Title	**Kinematics of Rigid Bodies**		3
	5.1	Instantaneous center of rotation for the velocity of bodies in plane motion, (up to 2 linkage mechanism)	3	
6	Self-Study	1. Applications of resultant of forces, concept of couple and moments, 2. Centroid and center of gravity, analysis of trusses. 3. Kinetics of rigid body, work energy principle. 4. Principle of Law of Conservation of momentum, Impact and collision.	1,2,3	6*
			Total (*Not Included)	28

Laboratory Component if any

Sr. No.	Title of the Experiment
1	Draw the force polygon and determine the equilibrant force for concurrent coplanar force system.
2	Use the conditions of equilibrium for parallel force system and determine the support reactions.
3	Apply the principle of moment for equilibrium of levers.
4	Determine the coefficient of friction for glass slab and a metal plate on an inclined plane.
5	Determine the axial forces using Lami's theorem for Jib crane apparatus.
6	Use the conditions of equilibrium for non-concurrent non-parallel force system and draw the force polygon.
7	Measure the acceleration due to gravity with the help of simple pendulum apparatus.
8	Determine the range of projectile and the time of flight for the projectile motion.
9	Verify the law of conservation of momentum and determine the coefficient of restitution for collision
10	(Plot the motion of projectile using air-cushion table apparatus.) A small project based on Engineering Mechanics concept.

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Vector Mechanics for Engineers statics and dynamics	9th	Beer and Johnston	McGraw Hill	2010
2	Engineering Mechanics	5th	Bhavikatti S S and Rajsekharappa	New Age International	2009
3	Engineering Mechanics Statics and Dynamics	14th	A K Tayal	Umesh Publication, Delhi	2012

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
3	Engineering Mechanic: Statics and Dynamics,	5th	E.W. Nelson, C.L. Best, W.G. McLean,	McGraw Hill	1998
4	Singer's Engineering Mechanics Statics and Dynamics	3rd	Vijaya Kumar Reddy. K. and Suresh Kumar. J	BS Publication	2012

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(ESC)	Problem Solving using OOP	2	0	4	3	7	2	0	2	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
CS102		Theory	--		--		--			--
		Laboratory	300		--		100			400

Pre-requisite Course Codes, if any.	Problem Solving using Imperative Programming
Course Objective: To learn problem solving using Object-Oriented programming paradigm	
Course Outcomes (CO): At *the End of the course students will be able to*	
CS102.1	Apply concepts of object-oriented programming using classes and objects
CS102.2	Apply Inheritance for a given scenario
CS102.3	Apply polymorphism for solving a given problem
CS102.4	Apply abstraction and exception handling to create efficient program.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS102.1	2	2	2									
CS102.2	2	2	2									
CS102.3	2	2	2									
CS102.4	2	2	2									

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS102.1							
CS102.2							
CS102.3							
CS102.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Department of EXTC

Theory (This course content delivery will be in C++/Java. Course Contents to be taken care accordingly)

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction and Encapsulation**		8
	1.1	Introduction to Object Oriented Programming, Procedural verses Object Oriented Programming, Principles, Benefits and applications of Object-Oriented Programming.	1,2	
	1.2	Encapsulation: Problem solving with Objects and Classes		
	1.3	Static data member and methods, constructors and their types. Types of functions and keywords, Strings, Arrays		
2		**Inheritance**		6
	2.1	Concept of Inheritance, parent class, derived class, base class, and derived class constructor	1,2	
	2.2	Types of inheritance: single, multiple, multilevel, hierarchical, hybrid		
	2.3	Aggregation and Composition		
3		**Polymorphism**		6
	3.1	Static Polymorphism: Method overloading and Constructor overloading	1,2	
	3.2	Dynamic Polymorphism: Method overriding		
	3.3	Data conversion		
4		**Abstraction**		2
	4.1	Abstraction: abstract class	1,2	
5		**Exception Handling**		6
	5.1	try, throw, and catch exceptions	1,2	
	5.2	Function exception declaration		
6	**Self Study**	File Handling, $STL, $pointers, $virtual functions @Multithreading, @Packages, @interface	1,2	5*
			Total (*Not included)	28+

$ only for C++

@ only for Java

**** Language used: C++ for Etrx and Extc Branch**

**** Language used: C++ / Java for IT and CE Branch**

Department of EXTC

Laboratory Component

Sr. No.	Title of the Experiment
1	Program on Encapsulation: Write a program to demonstrate classes and objects
2	Program on Encapsulation: Write a program to demonstrate constructor
3	Program on Polymorphism: Implement a Program to demonstrate method overloading,
4	Program on Polymorphism: Implement a Program to demonstrate constructor overloading
5	Program on Polymorphism: Implement a Program to demonstrate method overriding
6	Program on Inheritance: Implement a Program to demonstrate single, multilevel Inheritance
7	Program on Inheritance: Implement a Program to demonstrate multiple Inheritance
8	Program on Abstraction: Implement a Program to demonstrate Abstraction using abstract class
9	Program on Abstraction: Implement a Program to demonstrate multithreading/ STL
10	Program to demonstrate File Handling

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Object Oriented Programming with C++	Sixth	E Balagurusamy	Tata McGraw Hill	2017
2	Oriented Programming in Turbo C++	Fourth	Robert Lafore	Galgotia	2001
3	Java -The Complete Reference	Tenth	Herbert Schildt	Tata McGraw-Hill	2017
4	Java Programming From the Ground Up	First	Ralph Bravaco, Shai Simoson	Tata McGraw-Hill	2009

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	The Compete Reference C++	Fourth	Herbert Schlitz	Tata McGraw Hill	2017
2	An introduction to Programming and Object Oriented Design using Java	Third	Jaime Nino, Frederick A. Hosch	Wiley Student Edition	2010

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Digital Systems and Microprocessor	3	0	2	5	10	3	0	1	4
		Examination Scheme								
EC101		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To prepare students to perform the analysis and design of various digital electronic circuits and introduce them to the concept of microprocessors	
Course Outcomes (CO): At *the End of the course students will be able to*	
EC101.1	Explain various logic gates, SOP, POS forms and their minimization with k- map for given combinational circuits.
EC101.2	Construct combinational circuits using given MSI devices.
EC101.3	Apply the knowledge of flip-flops and MSI to design sequential circuits
EC101.4	Compare the logic families based on their characteristics
EC101.5	Comprehend the architectural features of 8085 with basic assembly language programming

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC101.1	3	3	3		3							
EC101.2	3	3	3		3							
EC101.3	3	3	3		3							
EC101.4	3	2	2		3							
EC101.5	3	2	2		3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC101.1	2	2	3	3	3	2	2
EC101.2	2	2	3	3	3	2	2
EC101.3	2	2	3	3	3	2	2
EC101.4	2	3	3	3	3	3	2
EC101.5	3	3	3	3	3	3	3

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Combinational Circuits**		**11**
	1.1	**Logic Gates:** Basic gates, Universal gates, Sum of products and products of sum, minimization with Karnaugh Map (up to four variables), Quine McCluskey method and realization.	1,4	
	1.2	**Combinational Circuits using basic gates as well as MSI devices:** Half adder, Full adder, Half Subtractor, Full Subtractor, Multiplexer, Demultiplexer, Decoder, Comparator	1,4	
2	**Title**	**Sequential Circuits**		**11**
	2.1	**Sequential Logic:** Latches and Flip-Flops. Conversions of Flip-Flops.	1,4	
	2.2	**Counters:** Asynchronous Counters, Synchronous Counters, Up Down Counters, Mod Counters, Ring and Twisted Ring Counters, Shift Registers, Universal Shift Register	1,4	
	2.3	MSI counters (IC 7490, IC 74160, IC 74163, IC 74169), MSI Shift registers (IC 74194) and their applications	2,5	
3	**Title**	**Clocked Synchronous Machines**		**05**
	3.1	Mealy and Moore Machines, clocked synchronous state machine analysis, State reduction techniques.	2,5	
4	**Title**	**Logic Families**		**05**
	4.1	Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out, and Fan-in), transfer characteristics of TTL NAND.	1,4	
5	**Title**	**Introduction to Microprocessors**		**10**
	5.1	Evolution of computers and Microprocessors	3	
	5.2	Essential components of a conventional Central Processing Unit (CPU)	3	
	5.3	Architecture of 8-bit microprocessor 8085	3	
	5.4	Basic instruction set with its addressing modes and concepts of Instruction cycle, Machine cycle and T states. Elementary programming in assembly language.	3	
	5.5	Elements of I/O data transfer with the concept of interrupts	3	
6	**Self Study**	Concepts of PROM, PAL and PLA. Timing Considerations and Meta-stability in Flip-Flops. Clocked synchronous state machine design. Interfacing CMOS to TTL and TTL to CMOS. Concepts of peripherals and memory with its interfacing with 8085 microprocessors		**5***
			Total (*Not included)	**42**

Department of EXTC

Laboratory Component, if any (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	To implement the combinational logic for given function using basic gates/MSI ICs. a. To study and verify the truth table of logic gates b. To study the universal NAND and NOR gate c. To study the working of half adder, full adder, half subtractor, Full subtractor along with truth table
2	To implement TTL and CMOS logic family a. To study TTL NAND gate (BJT implementation). b. To study CMOS NAND gate c. To study interfacing of the TTL /CMOS
3	To implement 4-bit, 5-bit and 8-bit comparator using given MSI
4	To design implement gate level multiplexers and MSI multiplexers
5	To design and implement gate level and MSI circuits of flip-flops
6	To design counters a. To design a MOD4 synchronous up/down counter b. To study IC 7490 – Asynchronous Decade Counter
7	To synchronous counters, synchronous counters and shift register using given MSI. a. To study IC 74160 as Synchronous Decade Counter and Mod 6 counter b. To study IC 74163 as Synchronous MOD 16 Counter and Mod 10 counter c. To verify the truth table of IC 74194 as Universal Shift Register and implement Ring and Twisted Ring Counter.
8	To perform basic arithmetic operations through assembly language program in 8085
9	To simulate COPY and PASTE operation through 8085 assembly programs
10	To write a program to add N elements stored in an array of 8 bit numbers (8085)

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Modern Digital Electronics	Forth	R. P. Jain	Tata McGraw Hill	**2009**
2	Digital Design Principles And Practices	Third	John F. Wakerly	Pearson Education	**2001**
3	Microprocessor Architecture, Programming, and Applications with the 8085	Sixth	Ramesh S. Gaonkar	Penram International	**2013**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
4	Digital Design	Forth	Morris Mano	Pearson Education	**2008**
5	Fundamentals of digital logic design with VHDL	Second	Stephen Brown and ZvonkoVranesic	McGraw Hill	**2006**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SBC	Communication Skills	1	0	2	2	5	1	0	1	2
		Examination Scheme								
AS107		Component	ISE		MSE		ESE		Total	
		Theory	--		50**		--		50	
		Laboratory	150*		--		--		150	

** MSE will be evaluated based on written test based on module 1 and 2.
** ISE will be evaluated based on marks scored in practical, out of 150.

Pre-requisite Course Codes, if any.	
Course Objective: To apply the principles of communication in personal and professional environment.	
Course Outcomes (CO): At *the end of the course students will be able to*	
AS107.1	Apply the principles of business writing for professional documents.
AS107.2	Develop advance vocabulary and grammar for spoken and written communication.
AS107.3	Design the draft a formal speech.
AS107.4	Analyze received information by using active listening and reading skills.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS107.1										2		
AS107.2										2		
AS107.3										2		
AS107.4										2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS107.1							
AS107.2							
AS107.3							
AS107.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	L Hrs.	P Hrs
1	Title	**Vocabulary Building & Grammar**		2	4
	1.1	Concept of word formation, the root words from foreign languages and their use in English	7,1		
	1.2	Common errors in writing, confused pair of words, redundancies, clichés	6, 2		
2	Title	**Writing Skills**		7	14
	2.1	Principles of Business Writing: 7Cs of communication, sentence structures, Organizing paragraph in direct and indirect style; Summarization	4		
	2.2	Practices in Writing: E-mail Etiquettes, e-mail for business purposes	3		
	2.3	Critical Reading: understanding the concept of critical reading and applying to analyze a given text.	5		
3	Title	**Oral Skills**		5	10
	3.1	Listening Comprehension(audio): Pronunciation, intonation, Stress and Rhythm	5		
	3.2	Speaking Practices: 1. Common everyday situation: Conversation and dialogues (group activity, ice-breaking session) 2. Public Speaking: Extempore, formal speech	3		
4	Self-Study	1. Basic Rules of Grammar 2. GRE Vocabulary 3. Reading a book (fiction/non-fiction) and preparing a review on it			6*
			Total (*Not included)	**42hrs**	

List of activities (Graded, Non-graded)

Sr. No.	Title of the assignments	Marks
1	Skit based on a given situation	-
2	ISE 1 – Summary Writing	10
3	ISE 2 – Extempore	10
4	ISE 3 – Grammar	20
5	ISE 4 – Vocabulary	20
6	Reviewing a book (fiction/ non-fiction)	10
7	ISE 5 – Email Writing (Inquiry)	20
8	ISE 6 – Email Writing (Complaint)	20
9	ISE 6 – Speech	20
10	ISE 7 – Critical Reading	20
	Total	**150**

Text Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Communication Skills	2013	Shirley Mathews	Technical Publication, Pune	2013
2	English Vocabulary in Use	1999	Michael McCarthy , Felicity O'Dell	Cambridge University Press, India	1999

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Oxford Practice Grammar	1999	John Eastwood	Oxford, India	1999
2	Communication Skills	2011	Meenakshi Raman, Sangeeta Sharma	Oxford, India	2011
3	Communication Skills	2010	Dr. Meera Bharwani	Synergy Knowledge-ware, India	2010
4	English Grammar for Today	2005	Geoffrey Leech	Palgrave, UK	2005
5	Word Power Made Easy	1978	Norman Lewis	Anchor Books, New York	1978

Department of EXTC

Semester III									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	BSC	MA201	Linear Algebra	2	0	2	5	09	3
1	BSC*	MA202	Foundation of Mathematics-I*	2	1	0	6	09	3
2	PC	EC201	Computer Architecture & Organization	3	0	2	4	09	4
3	PC	EC202	Electronic Devices	3	0	2	4	09	4
4	PC	EC203	Network Theory	3	0	2	4	09	4
5	SBC	EC204	Electronic Instruments and Measurement Lab	0	1	2	2	05	2
6	SBC	AS201	Communication Skills	1	0	2	2	05	2
7	ABL	SVXX/ STXX	SEVA II or III /SATVA II or III	0	0	0	0	03	1
8	HSSE	HSEXX	HSS-I	2	0	0	3	05	2
TOTAL				**16**	**2**	**12**	**30**	**63**	**25**

**Only for Lateral Entry Students*

Semester IV									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	BSC	MA203	Probability and Stochastic Processes	3	0	0	5	08	3
1	BSC*	MA204	Foundation of Mathematics-II	2	1	0	6	09	3
2	PC	EC205	Analog Circuits	3	0	2	6	11	4
3	PC	EC206	Microcontrollers	3	0	2	6	11	4
4	PC	EC207	Signals and Systems	3	0	2	6	11	4
5	SBC	EC208	Mini Project-I	0	0	0	4	04	2
6	ABL	SVXX/STXX	SEVA II or III /SATVA II or III	0	0	0	3	01	1
7	HSSE	HSEX2	HSS-II	2	0	0	3	05	2
8	S/M	SCX1/MNX1	SCOPE-I/Minor-I						3
TOTAL				**16**	**1**	**6**	**39**	**60**	**26**

**Only for Lateral Entry Students*

Second Summer for HSC students									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	MLC	AS202	Constitution of India	1	0	0	05	06	NC

Second Summer (For Lateral Entry Students)									
No.	**Type**	**Code**	**Course**	**L**	**T**	**P**	**O**	**E**	**C**
1	BSC	MA201	Linear Algebra	2	0	2	5	09	3
1	BSC	MA203	Probability and Stochastic Processes	3	0	0	5	08	3
2	MLC	AS202	Constitution of India	1	0	0	05	06	NC

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

Semester-III

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Linear Algebra	2	0	2	5	9	2	0	1	3
		Examination Scheme								
MA201		Component	ISE		MSE		ESE		Total	
		Theory	50		50		100		200	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	MA101, MA102
Course Objective: To develop mathematical skills for solving engineering problems.	
Course Outcomes (CO): At *the End of the course students will be able to:*	
MA201.1	Solve a homogeneous and non-homogeneous system of linear equations using rank of amatrix.
MA201.2	Solve system of linear equations by Numerical Methods.
MA201.3	Solve equations in real life problems and to encode and decode messages using the concept of matrices.
MA201.4	Identify whether given structures are vector spaces and subspaces and construct a basis for them.
MA201.5	Show if a given matrix is diagonalizable or not.
MA201.6	Apply concepts of Eigenvalues and eigenvectors to calculate functions of a square matrix, Google page rank vector and solve systems of differential equations using diagonalization of matrices.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA201.1	3											
MA201.2	3											
MA201.3	3	1										
MA201.4	3											
MA201.5	3											
MA201.6	3	1										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA201.1							
MA201.2							
MA201.3							
MA201.4							
MA201.5							
MA201.6							

Department of EXTC

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	**Basics of matrices**	3,5	03
	1.1	Revision of basic matrices and types of matrices.		01
	1.2	Row echelon form, Reduced Row Echelon form, Rank of a matrix.		02
2	Title	**Linear equations & its solutions**	1,2,3,5	07
	2.1	Consistency and solution of simultaneous linear homogeneous and non-homogeneous equations.		02
	2.2	Application of solving systems of equations in traffic control.		01
	2.3	Solution of system of linear algebraic equations, by (1) Gauss Elimination Method (2) Gauss Jordan method (3) Gauss Jacobi Iteration method (4) Gauss Seidel Method. (5) LU Decomposition -Crout's method		04
3	Title	**Vector spaces (over field of real numbers)**	1,2,5	08
	3.1	Vector space, subspace, span, linear dependence and independence of vectors, basis, dimension, orthogonal projection & gram-Schmidt process. Null space, row space, column space, Rank-Nullity theorem (only statement). Least square method.		08
4	Title	**Encoding & decoding using Matrices.**	4	02
	4.1	Application of matrices to Coding and Decoding		02
5	Title	**Eigenvalues and Eigenvectors**	1,2,3,5	08
	5.1	Eigenvalues, Eigenvectors and its properties. Cayley Hamilton theorem and its applications. Diagonalization of matrices. Derogatory and Non-derogatory matrices.		04
	5.2	Application to find google page rank. Functions of a square matrix. Solving system of differential equations using diagonalization.		04
6	Self-Study	1.2 Normal form. 2.2 Forming equations using KVL for circuits and solving them using matrices. 3.1 Singular Value Decomposition. 5.1 Additional properties with proofs of eigenvalues and eigenvectors.	1,2,3,5	05*
			Total (*Not included)	**28**

Department of EXTC

Laboratory Component, if any (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Introduction to Scilab (getting started) and its benefits to use as a mathematics tool.
2	Basic commands of scilab and vectors & matrix operations.
3	Conditional branching and iterations using Scilab.
4	Solution of linear equations using row-echelon and inverse of a matrix.
5	Solutions of linear equations using Gauss Elimination method.
6	Solutions of linear equations using Gauss Jordan method.
7	Solutions of linear equations using Gauss-Jacobi method.
8	Solutions of linear equations using Gauss-Seidel method.
9	Solutions of linear equations using Crout's method.
10	To find Eigen values and Eigenvectors using Scilab

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	Linear Algebra and its applications	4th	Gilbert Strang	Cengage	2014
2.	Higher Engineering Mathematics	44th	Dr. B. S. Grewal	Khanna Publications	2020

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1.	Linear Algebra and its applications	3rd	David. C. Lay	Pearson Education	2006
2.	Elementary Linear Algebra Application Version	6th	H Anton and Crorres	John Wiley & Sons	2010
3.	Advanced Engineering Mathematics	28th	H. K Das	S. Chand	2014
4.	Hill Ciphers	1st	Jonaki B Ghosh	At Right Angles	2015
5.	Advanced Engineering Mathematics	10th	Erwin Kreysizg	John Wiley & Sons	2011

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Foundations of Mathematics-I	2	1	0	6	9	2	1	0	3
MA202		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300

Pre-requisite Course Codes, if any.	-
Course Objective: To develop foundation of mathematical skills.	
Course Outcomes (CO): At *the End of the course students will be able to: -*	
MA202.1	Differentiate a function of one variable and partially differentiate a function of more than one variable.
MA202.2	Apply the concept of partial differentiation to find extreme values of a given function.
MA202.3	Find nth order derivative of a given function.
MA202.4	Expand a given function as a power series.
MA202.5	Perform operations on matrices and find inverses and determinants of them.
MA202.6	Perform vector operations and compute dot products and cross products between them.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA202.1	2											
MA202.2	2											
MA202.3	2											
MA202.4	1											
MA202.5	1											
MA202.6	1											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA202.1							
MA202.2							
MA202.3							
MA202.4							
MA202.5							
MA202.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	**Differential Calculus**	1,2	**18**
	1.1	Partial fractions. Derivatives of standard functions, product and quotient rule for differentiation.		04
	1.2	Partial derivatives of first and higher order, composite differentiation		03
	1.3	Application of partial derivatives: Local Maxima and Minima of functions of two variables.		02
	1.4	Successive Differentiation: Proofs of nth derivatives of standard functions. Use of partial fractions to calculate nth derivatives of given functions. Leibnitz theorem for nth derivative of product of two functions.		05
	1.5	Infinite series: expansion of functions in powers of x using maclaurin series. Taylor's series.		04
2	Title	**Matrices**	1,2	**07**
	2.1	Addition and scalar multiplication of matrices. Matrix multiplication, types of matrices.		03
	2.2	Elementary row transformations, finding inverses using matrices, determinants and its properties		04
3	Title	**Vectors**	1,2	**03**
	3.1	Vector definition, addition, scalar multiplication, dot product of two vectors, angle between two vectors, cross product.		03
			Total	**28**

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	**Higher Engineering Mathematics**	**44th**	**Dr. B. S. Grewal**	**Khanna Publications**	**2020**

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	**Advanced Engineering Mathematics**	**10th**	**Erwin Kreysizg**	**John Wiley & Sons**	**2011**
2	**Advanced Engineering Mathematics**	**28th**	**H. K. Dass**	**S. Chand Publications**	**2014**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Computer Architecture & Organization	3	0	2	4	9	3	0	1	4
EC201		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC101, Any Programming Language
Course Objective: Imparting concepts of each component of computer architecture thoroughly with practical aspects including memory systems and I/O communications with interfacing	
Course Outcomes (CO): *At the End of the course students will be able to*	
EC201.1	Describe basic computer structure and compare computer architecture models
EC201.2	Design algorithms to solve ALU operations and memory mapping techniques
EC201.3	Comprehend processor architecture with various design methods of CPU with comparative analysis
EC201.4	Describe memory systems with design and analysis of mapping techniques for cache and virtual memory
EC201.5	Analyze different parallel processing and pipelining concepts with pipelining hazards
EC201.6	Comprehend different types of I/O buses, compare and contrast different types of data transfer methods and arbitration techniques

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC201.1	3											
EC201.2		2		2								
EC201.3	2			2								
EC201.4		2		2								
EC201.5	2											
EC201.6	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC201.1							
EC201.2							
EC201.3							
EC201.4							
EC201.5							
EC201.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze √	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Overview of Computer Architecture and Organization**		**5**
	1.1	Introduction of Computer Organization and Architecture, Basic organization of computer and block level description of the functional units, Evolution of x86 Computers, Von Neumann model, Harvard Model, Embedded system	1	
	1.2	Performance Issues: Designing for performance, Amdahl's Law, Multi-core, GPGPU	1	
2	**Title**	**Data Representation and Arithmetic Algorithms**		**6**
	2.1	Number representation: Floating-point representation, Floating point arithmetic, IEEE 754 floating point number representation	2,3	
	2.2	Integer Data computation: Addition, Subtraction. Multiplication: Signed multiplication, Booth's algorithm.	2,3	
	2.3	Division of integers: Restoring and non-restoring division	2,3	
3	**Title**	**Processor Organization and Control Unit**		**9**
	3.1	CPU Architecture, Register Organization Instruction formats, basic instruction cycle. Instruction interpretation and sequencing, Case Study of 8086 Architecture and Register Organization.	1,2,4	
	3.2	Control Unit: Soft wired (Micro-programmed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations	2,4	
	3.3	RISC and CISC: Introduction to RISC and CISC architectures and design issues.	2,4	
4	**Title**	**Memory Organization**		**11**
	4.1	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAMS and ROM, Allocation policies, Memory hierarchy and characteristics.	1,2	
	4.2	Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory.	1,2	
	4.3	Virtual Memory: Concept, Segmentation and Paging, Page replacement policies	1,2,4	
5	**Title**	**I/O Organization and Introduction to Parallel Processing**		**11**
	5.1	Buses: Types of Buses, Bus Arbitration, BUS standards	2	
	5.2	I/O Interface, I/O channels, I/O modules and IO processor, Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA.	1,2	
	5,3	Introduction to parallel processing concepts, Flynn's classifications, pipeline processing, Pipeline stages, Pipeline Hazards	1,2,4	
6	**Self Study**	Comparative Study of microprocessors and micro architectures with respect to their important features.8086 instructions and assembler directives with addressing modes with memory interfacing techniques. Cache memory protocol and virtual memory concepts in Pentium processors. Vector and Array Processors with VLIW architecture		**4***
			Total (*Not included)	**42**

Department of EXTC

Laboratory Component, if any: (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Implementation of various Arithmetic Operations through Assembly Language Programming for microprocessor 8086 (MASM)
2	Simulate the operation of COPY and PASTE in 8086 (MASM)
3	Implement various String Operations in 8086 through the utilities provided by DOS interrupts (MASM)
4	Generation of alphabetic arrangement of a given string in 8086 (MASM)
5	Design password application (generation and detection) in 8086 (MASM)
6	Design of Carry Look Ahead Adder
7	Implementation and programming of Booth's Multiplication Algorithm
8	Implementation and programming of Division Algorithm (Non-Restoring and Restoring)
9	Implementation of Mapping techniques of Cache memory
10	Implementation of Page Replacement Policies

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Computer Organization	**Fifth**	Carl Hamacher, Zvonko Vranesic and Safwat Zaky	**Tata McGraw-Hill**	**2002**
2	Computer Organization and Architecture: Designing for Performance	**Eighth**	William Stallings	**Pearson**	**2010**
3	Computer System Architecture	**Third**	M, Morris Mano	**Pearson**	**1993 Reprinted 2007**
4	Computer Architecture & Organization	**Third**	John P. Hayes	**McGraw-Hill**	**1998**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Structured Computer Organization	**Sixth**	Andrew S. Tanenbaum	**Pearson**	**2013**
2	Microprocessor and Interfacing: Programming & Hardware	**Third**	Douglas V Hall	**Tata-McGraw Hill**	**2012**
3	Computer Architecture and Organization: Design Principles and Applications	**Second**	B. Govindarajulu	**McGraw Hill**	**Paperback -2017**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Electronic Devices	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC202		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	ES13 (Basic Electrical Technology)
Course Objective: To teach fundamentals of electronic devices	
Course Outcomes (CO): At *the End of the course students will be able to*	
EC202.1	Discuss device physics and characteristics of semiconductor devices.
EC202.2	Discuss working principle and characteristics of BJT
EC202.3	Discuss working principle and characteristics of FET
EC202.4	Analyze single stage BJT and FET amplifier circuits
EC202.5	Discuss semiconductor device fabrication process
EC202.6	Discuss construction, working principle and characteristics of advance semiconductor devices HEMT, MESFET and HBT

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC202.1	2	1			2							
EC202.2	2	1			2							
EC202.3	2	1			2							
EC202.4	2	3			2							
EC202.5	2	1			2							
EC202.6	2	1			2							3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC202.1							
EC202.2							
EC202.3							
EC202.4							
EC202.5							
EC202.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	**Understand√**	**Apply√**	**Analyze√**	**Evaluate**	**Create**

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Diode**	1	**6**
	1.1	Review of PN Junction Analysis		
	1.2	Applications of Diode: Simple diode model, Limiter circuits, Rectifiers, Clamper Circuits, Peak Detector and Voltage Doubler		
	1.3	Zener diode and Schottky diode		
2	**Title**	**Bipolar Devices**	1,2	**11**
	2.1	BJT: The bipolar transistor action, minority carrier distribution, low-frequency common-base current gain, non-ideal effects, Ebers-Moll Model and Hybrid-Pi Model		
	2.2	Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT amplifiers, bias stability, various configurations (such as CE, CB, CC) and their features, small signal analysis, low frequency models, estimation of voltage gain, input resistance, output resistance etc., design procedure for specifications, frequency analysis of multistage amplifiers.		
3	**Title**	**Field Effect Devices: JFET**	1,2	**11**
	3.1	Construction, operation, and device characteristics		
	3.2	Biasing schemes for FET amplifiers, bias stability, various configurations (such as CS, CG, CD) and their features, small signal analysis, low frequency models, estimation of voltage gain, input resistance, output resistance etc., design procedure for specifications, frequency analysis of multistage amplifiers.		
4	**Title**	**Field Effect Devices: MOSFET**	2	**10**
	4.1	Two terminal MOS structure, MOSFET construction, Band diagrams under equilibrium and external bias, Threshold Voltage		
	4.2	V-I and CV characteristics, Channel length modulation, Short Channel effects, MOSFET Model		
5	**Title**	**Integrated circuit fabrication process**	R-3	**4**
	5.1	Oxidation, diffusion, ion implantation, photolithography		
	5.2	Etching, chemical vapor deposition, sputtering, twin-tub CMOS process.		
6	**Self-Study**	Device structure, principle of operation and V-I characteristics of MODFET (i.e. HEMT), MESFET and HBT		**4***
			Total (*Not included)	**42**

Department of EXTC

Laboratory Component, if any (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	To plot forward and reverse characteristics of semiconductor diode
2	Implement clipper and clamper circuits using diode
3	Implement half-wave and full-wave rectifier circuits
4	To plot characteristics of Zener diode and observe Zener as voltage regulator
5	Finding characteristics of BJT configurations (CE/CB/CC) using simulation and hardware implementation.
6	Obtain the operating point for different biasing circuits
7	Design and implement single stage BJT based amplifier for the required specifications.
8	Obtain frequency response of single stage BJT based amplifier
9	Finding characteristics of FET (CG/CS/CD) using Simulation and Hardware Implementation
10	Design and implement single stage FET based amplifier for the required specifications.
11	Obtain frequency response of single stage FET based amplifier
12	Obtain Input-Output Characteristics of MOSFET using circuit simulator

Textbooks:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Electronic Devices and Circuits	Eleventh	RL Boylestad and Lous Nashelsky	Prentice Hall	2013
2	Electronic Circuit Analysis and Design	Third	Donald A. Neamen	Tata McGraw Hill	2006

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Semiconductor Physics and Devices	Fourth	Donald A. Neamen and Dhrubes Biswas	Tata McGraw Hill	2017
2	CMOS Digital Integrated Circuits	Fourth	Sung-Mo Kang, Yusuf Leblebici and Chulwoo Kim	Tata McGraw Hill	2019
R-3	Semiconductor Devices: Physics and Technology	Third	S. M. Sze and Ming-Kwei Lee	Wiley	2015

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Network Theory	3	0	2	4	09	3	0	1	4
EC203		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		75		75		150		300
		Laboratory		50		--		50		100

Pre-requisite Course Codes, if any.	ET101
Course Objective: To teach fundamental theorems for circuit analysis.	
Course Outcomes (CO): At *the End of the course students will be able to*	
EC203.1	Analyze the given circuits using theorems and transformation techniques
EC203.2	Analyze the given circuit using Graph Theory
EC203.3	Analyze the given RL, RC and RLC circuits in time domain
EC203.4	Analyze the given RL, RC and RLC circuits in frequency domain
EC203.5	Predict the circuits using Foster and Cauer realization methods
EC203.6	Explain the concept of two port network, relation between the parameters and their interconnection

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC203.1		3										
EC203.2		3										
EC203.3		3										
EC203.4		3										
EC203.5	3											
EC203.6	3											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC203.1					3	2	
EC203.2					3	2	
EC203.3					3	2	
EC203.4					3	2	
EC203.5					3	2	
EC203.6					3	2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze√	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Analysis of DC circuits** and **coupled circuits:**		12
	1.1	Analysis of circuits with and without controlled sources using generalized loop, node matrix, Superposition, Thevenin, Norton, Maximum Power transfer.	3	
	1.2	Self and mutual inductances, coefficient of coupling, Dot convention, equivalent circuit, solution using loop analysis	1	
2	Title	**Graph Theory:**		4
	2.1	Concept of loop, tree, co-tree, incidence matrix, cut set matrix and tie set matrix	4	
	2.2	Duality principle and its application	4	
3	Title	**Transient Analysis:**		12
	3.1	**Time domain analysis of R-L and R-C circuits:** Forced and natural response, time constant, initial and final values	1,3	
	3.2	**Time domain analysis of R-L-C circuits:** Forced and natural response, effect of damping **Solution using second order equation for standard input signals:** Transient and steady state time response	1,3	
	3.3	**Frequency domain analysis of RLC circuits:** S-domain representation, applications of Laplace Transform insolving electrical networks	1,3	
4	Title	**Network Synthesis:**		6
	4.1	**Network Function:** driving point and transfer function, Poles and Zeros, calculation of residues by analytical and graphical method, frequency response	2	
	4.2	**Positive real functions:** Concept of positive real function, testing for Hurwitz polynomials, testing for necessary and sufficient conditions for positive real functions	2	
	4.3	**Synthesis of RC, RL, LC circuits:** Concepts of synthesis of RC, RL, LC driving point functions.	2	
	Title	**Two Port Network:**		8
	5.1	**Parameters:** Open Circuit, Short Circuit, Transmission and Hybrid parameters, relationships among parameters, reciprocity and symmetry conditions	1	
	5.2	**Series/parallel connection:** T and Pi representations, interconnection of Two-Port networks	1	
6	Self-Study	**Millman's theorem, Telogen's theorem, Nonplanar graphs, Solution using first order equation for standard input signals, Transient and steady state time response, solution using universal formula, Terminated Two-Port networks**		4*
			Total (*Not included)	42

Department of EXTC

Laboratory Component

Sr. No.	Title of the Experiment
1	To measure and calculate currents and voltages for a given resistive circuit and verify KCL and KVL.
2	To verify superposition theorem experimentally for a given resistive circuit consisting of two independent sources.
3	To verify Thevenin's theorem experimentally for a given circuit.
4	To verify maximum power transfer theorem experimentally for a given circuit.
5	To verify reciprocity theorem experimentally for a given circuit.
6	To measure and calculate RC time constant for a given RC circuit.
7	To measure and calculate RC time constant for a given RL circuit.
8	To measure and analyze (settling time, overshoot, undershoot, etc.) step response of for a given series RLC circuit for following cases: (1) $\zeta = 1$ (critically damped system), (2) $\zeta > 1$(over damped system), (3) $\zeta < 1$ (under damped system). Choose appropriate values of R, L, and C to obtain each of above cases one at a time.
9	To measure and calculate Z-parameters for a given two-port system.
10	To measure and calculate Y-parameters for a given two-port system.
11	To measure and calculate h-parameters for a given two-port system.
12	To measure and calculate ABCD-parameters for a given two-port system.

Design based Problems (DP)/Open Ended Problem:

1. Write a 'c' program to obtain RC time constant from a given step response of RC circuit.
2. Write a 'c' program to plot frequency response of RC circuit for different values of R and C.
3. Write a 'c' program to obtain 3-dB bandwidth and RC time constant from a given frequency response of RC circuit.
4. Write a 'c' program to plot impedance of a given series RLC circuit as a function of frequency. Also obtain minimum value of impedance and series resonance frequency using 'c' program.
5. Write a 'c' program to obtain following parameters from step response of series RLC circuit for different values of R, L and C.
    a. Propagation delay
    b. Overshoot
    c. Undershoot
    d. Damping factor
    e. Natural frequency
    f. Settling time

Department of EXTC

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Circuit Theory	Seventh Revised Edition	A. Chakrabarti	Dhanpat Rai and Co., New Delhi	**2018**
2	Network Analysis	Third Edition	M E Van Valkenburg	Prentice-Hall of India Pvt. Ltd.	**2018**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
3	Network Analysis and Synthesis	Second Edition	Franklin F Kuo	Wiley	**2006**
4	Networks and Systems	Second Edition	D. Roy Choudhury	New Age International Pvt. Ltd, Wiley	**2009**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Electronics Instruments and Measurement Lab	0	1	2	2	5	0	1	1	2
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
EC204		Theory		--		--		--		--
		Laboratory		150		--		50		200

Pre-requisite Course Codes, if any.	ET101
Course Objective: To teach principle of working and application of various measuring instruments used in Electronics Laboratories	
Course Outcomes (CO): At *the End of the course students will be able to*	
EC204.1	Describe the working of measuring instruments available in the lab
EC204.2	Find out and verify the manufacturers, make, models, market cost and specifications of the given instrument
EC204.3	Select the suitable test and measuring instrument for the given circuit
EC204.4	Operate the instrument for observing and recording the given signal in time domain and frequency domain
EC204.5	Recognize the importance of calibration of instruments
EC204.6	Design signal conditioning circuit for measurement of various parameters

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC204.1	2	1			3							
EC204.2	2	1			3							2
EC204.3	2	2			3							
EC204.4	2	1			3							
EC204.5	2	1			3							
EC204.6	2	1	3		3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC204.1							
EC204.2							
EC204.3							
EC204.4							
EC204.5							
EC204.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze	Evaluate	Create

Department of EXTC

Sr. No.	Title of the Experiment
1	Measurement of static parameters using analog ammeter, voltmeter, and galvanometer.
2	Exploring controls of CRO/DSO and measurement of various parameters in the given circuit using CRO/DSO
3	Study of working principle and exploring controls of function generator, signal generator and arbitrary function generator
4	Study of working principle of tachometer, lux meter, clamp meter and thermal camera and demonstrate its use.
5	Study of working principle of multimeter, wattmeter & energy meter and demonstrate its use.
6	Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)
7	Designing signal Conditioning circuit for Strain Measurement
8	Designing AC bridge Circuit for capacitance measurement and verification using Q-meter
9	Designing signal Conditioning circuit for Temperature Measurement
10	Designing signal Conditioning circuit for Distance Measurement

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SBC	Professional Communication Skills	1	0	2	2	5	1	0	1	2
AS201		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory			--		--			
		Laboratory	200		--		--			200

Pre-requisite Course Codes, if any.	
Course Objective: To demonstrate the desired spoken and written communication skills required in early professional life, with focus on job placements.	
Course Outcomes (CO): At *the End of the course students will be able to*	
AS201.1	Demonstrate the spoken and written skills for job placements.
AS201.2	Draft professional documents.
AS201.3	Design written communication for social media.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS201.1										2		
AS201.2										2		
AS201.3										2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS201.1							
AS201.2							
AS201.3							

BLOOM'S Levels Targeted (Pl. appropriate)

Remember	Understand	Apply√	Analyze√	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	L Hrs.	P Hrs
1.	**Title**	**Placement Skills**		**6**	**12**
	1.1	Resume Writing & Cover Letter			
	1.2	Group Discussion			
	1.3	Case Studies/Pitching a startup			
	1.4	Team Building Skills/Work			
	1.5	Interview Skills			
2	**Title**	**Corporate Communication**		**6**	**12**
	2.1	Presentation Skills			
	2.2	Meeting: Notice, Agenda, Minutes			
	2.3	Proposal Writing			
	2.4	Report Writing: Informative, Analytical report			
3	**Title**	**Research Writing**		**2**	**4**
	3.1	Sourcing information through digital media			
	3.2	Written communication using social media: Blog			
4	**Self Study**	Research Paper, News Analysis			**6***
			Total(*Not included)	**42 hrs**	

List of ISEs

Sr. No.	Title of the Experiment	Marks
1	Resume	20
2	Cover Letter	20
3	GD	40
4	Mock Interview	20
5	Presentation	20
6	Blog Writing	20
7	Team Building Activity	--
8	Minutes of the Meeting/Notice & Agenda	20
9	Proposal Writing	20
10	Report Writing	20
Total		**200**

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Interpersonal Skills at Work	2002	John Hayes	McGraw Hill Education	2002
2	Campus Placement: A Comprehensive Guide	2016	Ankur Malhotra	McGraw Hill Education	2016

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	If I Understood You, Would I Have This Look on My Face? My Adventures in the Art and Science of Relating and Communicating	2017	Alan Alda	Random House	2017
2	Handbook for Writing Proposals	2010	Robert J. Hamper, Sue Baugh	McGraw Hill Education	2010
3	Effective Communication Skills for Scientific and Technical Professionals	2000	Harry Chambers	Paperback Basic Books	2000
4	The Art of Writing Together	2008	William Issac	Crown Business	2008
5	Communication Skills	2011	Meenakshi Raman, Sangeeta Sharma	Oxford, India	2011

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
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Department of EXTC

Semester-IV

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Probability and Stochastic Processes	3	0	0	5	8	3	0	0	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
MA203		Theory		75		75		150		300
		Laboratory		-		--		-		-

Pre-requisite Course Codes, if any.	MA101, MA102
Course Objective: To provide the fundamentals and advanced concepts of probability theory and random process to support core courses in electronic and Electronic and communication engineering. The required mathematical foundations will be studied at a fairly rigorous level and the applications of the probability theory and random processes to engineering problems will be emphasized.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MA203.1	Apply concepts of mathematics to set operations and probability theory
MA203.2	Apply concepts of probability theory to single random variables
MA203.3	Apply theorems to multiple random variables and investigate significance of Central Limit Theorem.
MA203.4	Determine solutions to various characteristics of random variables/distributions/processes
MA203.5	Investigate characteristics of random processes
MA203.6	To interpret use of probability distributions in real world and illustrate Markov Theory application to Queuing theory.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA203.1	3	3			1				1	3		1
MA203.2	3	3			1				1	3		1
MA203.3	3	3			1				1	3		1
MA203.4	3	3			1				1	3		1
MA203.5	3	3			1				1	3		1
MA203.6	3	-							1	3		1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA203.1	2	2					
MA203.2	2	2					
MA203.3	2	2					
MA203.4	2	2					
MA203.5	2	2					
MA203.6	2	2					

Department of EXTC

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Probability**	1,2	08
	1.1	Sets and set operations; Probability space; Conditional probability and Bayes theorem		
2	Title	**Single Random Variable**	1,2	08
	2.1	Discrete random variables, probability mass function, probability distribution function, example random variables and distributions		
	2.2	Continuous random variables, probability density function, probability distribution function, example distributions		
3	Title	**Multiple Random Variables**	1,2	10
	3.1	Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution		
	3.2	densities and moments; Characteristic functions of a random variable		
	3.3	Markov, Chebyshev and Chernoff bounds		
4	Title	**Sequence of Random Variables**	1,2	06
	4.1	Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square)		
	4.2	Limit theorems; Strong and weak laws of large numbers, central limit theorem.		
5	Title	**Random Process**	1,2	10
	5.1	Random process. Stationary processes. Mean and covariance functions. Ergodicity.		
	5.2	Transmission of random process through LTI. Power spectral density.		
6	Self-Study	**Application of different probability distributions (to any one field of interest but not limited to)** 1.Wireless Communication 2.Queuing theory 3. Networking 4. Digital Signal Processing. 5.VLSI	1,2	06*
			Total	**42**

***Not included in the total**

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Probability, Random Variables and Stochastic Processes	4th	A. Papoulis and S. Unnikrishnan Pillai	McGraw Hill	2002
2	Probability and Random Processes with Applications to Signal Processing	3rd	H. Stark and J. Woods	Pearson education	2002

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Probability And Random Processes for Electrical Engineering	3rd	Alberto Leon Garcia	Pearson education	2008
2	Probability, Statistics and Random Processes	3rd	T Veerarajan	McGraw Hill	2008

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSC)	Foundations of Mathematics-II	2	1	0	6	9	2	1	0	3
MA204		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300

Pre-requisite Course Codes, if any.	Foundations of Mathematics-I
Course Objective: To develop basic foundation of mathematical skills.	
Course Outcomes (CO): At *the End of the course students will be able to: -*	
MA204.1	Integrate a function of one variable using various techniques
MA204.2	Sketch basic curves and solve double and triple integrals.
MA204.3	Solve basic problems using properties of complex numbers.
MA204.4	Solve differential equations of first order.
MA204.5	Apply the techniques of solving first order differential equations to electrical engineering problems.
MA204.6	Solve differential equations of higher order

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA204.1	1											
MA204.2	1											
MA204.3	1											
MA204.4	2											
MA204.5	1	1										
MA204.6	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA204.1							
MA204.2							
MA204.3							
MA204.4							
MA204.5							
MA204.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	**Understand√**	**Apply√**	**Analyze**	**Evaluate**	**Create**

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	**Integral Calculus**	1,2	**13**
	1.1	Formulae for integral of standard functions, integration by parts, integration by method of substitution.		04
	1.2	Gamma functions, Beta functions. Differentiation under Integral sign with constant limits and one parameter.		04
	1.3	Standard curves (lines, circles, parabolas, ellipses). Concept of double integration. Evaluation of double and triple integrals.		05
2	Title	**Complex Numbers**	1,2	**03**
	2.1	Operations on complex numbers, polar form of a complex number, properties of a complex number.		03
3	Title	**Differential Equations**	1,2	**12**
	3.1	Exact differential equations. Linear differential equations of the first order and equations reducible to linear.		04
	3.2	Solving differential equations of first order in electrical networks.		01
	3.3	Linear differential equations with constant coefficients: complementary function and particular integral.		07
			Total	**28**

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	**Higher Engineering Mathematics**	**44th**	**Dr. B. S. Grewal**	**Khanna Publications**	**2020**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	**Advanced Engineering Mathematics**	**10th**	**Erwin Kreysizg**	**John Wiley & Sons**	**2011**
2	**Advanced Engineering Mathematics**	**28th**	**H. K. Dass**	**S. Chand**	**2014**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Analog Circuits	3	0	2	6	11	3	0	1	4
		Examination Scheme								
EC205		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	ET101, ET202
Course Objective: To teach fundamentals of analog electronic circuits	
Course Outcomes (CO): At *the End of the course students will be able to*	
EC205.1	Apply the concept of negative and positive feedback
EC205.2	Discuss differential amplifier and power amplifier circuits
EC205.3	Discuss fundamentals of operational amplifier IC
EC205.4	Design linear and non-linear applications using operational amplifier IC
EC205.5	Discuss various data conversion techniques
EC205.6	Design applications with special purpose ICs

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC205.1	1	1	2	2								
EC205.2	1	1	2	2								
EC205.3	1	1	2	2								
EC205.4	1	1	2	2								
EC205.5	1	1	2	2								
EC205.6	1	1	3	2								

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC205.1							
EC205.2							
EC205.3							
EC205.4							
EC205.5							
EC205.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	**Understand√**	**Apply√**	**Analyze√**	**Evaluate**	**Create**

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Feedback topologies and Oscillators**	1	8
	1.1	Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.		
	1.2	**Oscillators:** Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.) and LC oscillators (Hartley, Colpitt, Clapp etc.)		
2	Title	**Differential amplifier and Power Amplifier**	1	8
	2.1	**Current mirror:** Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load.		
	2.2	**Differential amplifier:** Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.		
	2.3	**Power amplifiers:** Power BJTs, Power MOSFETs, Heat Sinks, Class A, Class B, Class C and Class AB operation, Power efficiency		
3	Title	**Operational Amplifier**	2	12
	3.1	Functional Block Diagram of op amp, DC and AC characteristics of an op-amp, Ideal op-amp		
	3.2	**Linear Applications of Operational Amplifier** Inverting and non-inverting amplifier, adder, subtractor, integrator, differentiator, difference amplifier, instrumentation amplifier **Active Filters:** First order filters, second order active finite and infinite gain low pass, high pass		
	3.3	**Non-Linear Applications of Operational Amplifier** **Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector **Schmitt Triggers:** Inverting Schmitt trigger		
4	Title	**Data Converters**	2	6
	4.1	Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc.		
	4.2	Analog to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc.		
	4.3	Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.		
5	Title	**Special Purpose Integrated Circuits**	2	8
	5.1	Timer 555 and its applications		
	5.2	Three-terminal fixed (78XX series) and general purpose 723 voltage regulators.		

6	**Self-Study**	Multiplier IC's, Power Amplifier IC's, PLL and VCO. Design of applications using these IC's.	**6***
		Total (*Not included)	**42**

Laboratory Component, if any (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Design and implement any one negative feedback amplifier
2	Design and implement any one oscillator circuit
3	Design and implement differential amplifier with and without current mirror circuit
4	Design and implement any one power amplifier circuit
5	To measure (a) Input bias current, (b) Input offset current, (c)Input offset voltage & (d) Slew rate of the given Op-Amp IC 741.
6	Design and implement linear application using Op-Amp IC 741.
7	Design and implement non-linear application using Op-Amp IC 741
8	Design and implement active filter circuit using Op-Amp IC 741.
9	Design and implement data converter circuit
10	Design and Implement Multivibrator Circuits using IC 555
11	Design, Implement and analyze Voltage Regulator Circuit using IC 723.

Textbooks:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Electronic Circuit Analysis and Design	**Third**	Donald A. Neamen	Tata McGraw Hill	**2006**
2	Linear Integrated Circuits	**Fourth**	D. Roy Choudhury and S. B. Jain	New Age International Publishers	**2018**

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Millman's Electronic Devices and Circuits	**Third**	Jacob Millman, Christos C Halkias, and Satyabratata JIT	McGraw Hill	**2014**
2	Design with operational amplifiers and analog integrated circuits	**Fourth**	Sergio Franco	Tata McGraw Hill	**2016**
3	Op-Amps and Linear Integrated Circuits	**Fourth**	Ramakant A. Gayakwad	Pearson Prentice Hall	**2015**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Microcontrollers	3	0	2	6	11	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC206		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC101, ET201
Course Objective: Imparting the detailed architectural features of various microcontrollers like 8051, PIC and ARM along with integrated peripherals and programming	
Course Outcomes (CO): *At the End of the course students will be able to*	
EC206.1	Compare and contrast traditional microprocessor with traditional microcontroller 8051
EC206.2	Understand and describe architectural features of microcontrollers like PIC and ARM
EC206.3	Comprehend ARM core model and classify different modes of operation with justification
EC206.4	Classify various instructions with addressing modes of microcontrollers like PIC and ARM
EC206.5	Analyze the given problem statement and apply the programming concepts to solve the problem through program in PIC and ARM
EC206.6	Illustrate and utilize the integrated peripherals of 16- and 32-bit microcontrollers

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC206.1	3											
EC206.2	3											
EC206.3	3											
EC206.4	3											
EC206.5		3			3			3		3		
EC206.6		3	2									

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC206.1							
EC206.2							
EC206.3							
EC206.4							
EC206.5							
EC206.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze √	Evaluate	Create

Department of EXTC

Theory Component

Module	Unit	Topics	Ref.	Hrs.
1	**Title**	**Introduction of 8-bit Microcontroller – 8051**		**4**
	1.1	Overview of 8051 Family of Controllers	1	
	1.2	Architecture of 8051 with block diagram schematic	1	
	1.3	Brief description of integrated components of 8051	1	
2	**Title**	**PIC Microcontroller**		**10**
	2.1	Microcontroller architecture and Programming model	2	
	2.2	Instruction set with addressing modes	2	
	2.3	Programming and Problem-solving approaches	2	
3	**Title**	**PIC Integrated Peripherals**		**9**
	3.1	I/O Ports with its interfacing	2	
	3.2	Interrupt Structure	2	
	3.3	Timers with its configuration	2	
	3.4	Data Converters (ADC and DAC)	2	
	3.5	Serial I/O (SPI and I^2C protocol)	2	
4	**Title**	**ARM7TDMI(ARMv4T) Architecture**		**10**
	4.1	Features and advantages, ARM versions	3,4	
	4.2	Processor operating states, ARM core data flow model, operating	3,4	
	4.3	Instruction set with addressing modes	3,4	
5	**Title**	**LPC2148 ARM7 Processor Programming and Interfacing**		**9**
	5.1	Processor state changing (ARM←→THUMB), Exceptions, interrupts,	3,4	
	5.2	Timer Programming, Watchdog Timer	3,4	
	5.3	ADC and Sensor Interfacing	3,4	
	5.4	SPI and I2C Peripheral Interface	3,4	
6	**Self Study**	ARM-v7-M (Cortex-M3), Comparison of ARM-v&-A (Cortex A8), ARM-v7-R (Cortex R4), ARM-v7-M (Cortex M3). Application Case Study for PIC and ARM controllers		**6***
			Total (*Not included)	**42**

Department of EXTC

Laboratory Component, if any (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Programming the I/O Port of 8-bit 8051 Microcontroller and effectively interface the LED and switch.
2	Programming and Interfacing for utilization of on-chip resources like Timers and Serial Communication of 8-bit 8051 Microcontroller.
3	PIC assembly language programming and simulation
4	PIC LED/LCD interfacing and programming
5	PIC Timers and interrupts programming
6	PIC ADC Programming
7	ARM LEDs and Keyboard Interface
8	ARM Programming and Interfacing of sensors using on chip ADC
9	ARM Programming and Interfacing on chip Serial Port
10	ARM Programming and Interfacing on chip timer

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	The 8051 Microcontroller and Embedded Systems: Using Assembly and C	**Second**	Muhammad Ali Mazidi, Janice G. Mazidi and R. D. McKinlay	**Pearson**	**2006**
2	Fundamentals of Microcontrollers and Applications in Embedded Systems (with PIC18 microcontroller family)	**Fourth**	Ramesh Gaonkar	**Penram International Publishing Pvt. Ltd**	**2007**
3	ARM System Developer's Guide Designing and Optimizing System Software	**First**	Andrew N. Sloss, Dominic Sysmes and Chris Wright	**Elsevier Inc Morgan Kaufmann**	**2004**
4	ARM Architecture, Reference Manual	**Second**	David Seal	**Addison Wesley**	**2001**

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	PIC Micron roller: An Introduction to Software & Hardware Interfacing	**Second**	Han- Way Huang	**Cengage Learning**	**2005**
2	ARM System-on-Chip Architecture	**Second**	Steve Furber	**Addison-Wesley**	**2000**

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Signals and Systems	3	0	2	6	11	3	0	1	4
EC207		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	MA101, MA102
Course Objective: To develop strong foundation of continuous time signals and systems	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC207.1	Classify and illustrate various operations on signals and systems.
EC207.2	Analyze the properties of a continuous time signal in frequency domain and observe the spectrum.
EC207.3	Apply Laplace Transform on continuous time signals
EC207.4	Evaluate Linear Time Invariant system response using Laplace Transform
EC207.5	Design analog Butterworth and Chebyshev filter
EC207.6	Interpret system using state space model

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC207.1	3	-			3				3	3		2
EC207.2	3	2			3				3	3		2
EC207.3	3	2			3				3	3		2
EC207.4	3	2			3				3	3		2
EC207.5	3	2			3				3	3		2
EC207.6	3	-			1				3	3		1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC207.1	2	2				2	
EC207.2	2	2				2	
EC207.3	2	2				2	
EC207.4	2	2				2	
EC207.5	2	2				2	
EC207.6	2	2				-	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Overview of Continuous Time Signals and Systems**	1,2	08
	1.1	**Introduction:** Signals, systems, elementary signals, exponential, sine, step, impulse, ramp, rectangular, triangular and operations on signals		
	1.2	**Classification of signals:** Continuous Signals, deterministic and non-deterministic, periodic and aperiodic, symmetric (even) and asymmetric (odd), energy and power, causal and anti-causal signals.		
	1.3	Operations of Signals: Shifting, Scaling, Time Reversal, Addition and Multiplication, Convolution, Correlation		
2	Title	**Fourier Series and Fourier Transform**	1,2	10
	2.1	**Fourier series**: Orthogonal representation of signals, Continuous Time Fourier Series (CTFS), magnitude and phase spectra, Gibbs phenomenon, Parsevel's relation,		
	2.2	**Fourier Transform**: Fourier Transform and Inverse Fourier Transform on periodic and non-periodic signals, Limitations of Fourier Transform and need for Laplace Transform, Properties of Fourier Transform, Parsevel's relation, Energy and Power Spectral Density and Bandwidth.		
3	Title	**Laplace Transform**	1,2	04
	3.1	Laplace Transform, Properties of Laplace Transform, Relation between Laplace Transform and Fourier Transform,		
	3.2	Inverse Laplace Transform using Partial Fraction method		
4	Title	**Linear Time Invariant (LTI) Systems**	1,2	08
	4.1	**Classification of systems:** Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems.		
	4.2	Impulse Response, Transfer Function, Differential Equation, Stability of Systems, Frequency Response, Solution of Differential Equation using Laplace Transform		
5	Title	**Analog Filter Design**	1,2	12
	5.1	Design of Ideal Analog filter, Butterworth Low Pass Filter (LPF) design, Butterworth High Pass Filter (HPF) design, Butterworth Band Pass Filter (BPF) and Band Reject Filter design, Pole zero plot of Butterworth filters, Magnitude Spectrum		
	5.2	Equiripple Filters, Chebyshev Type-I LPF, HPF Design, Pole zero plot of Chebyshev filter, magnitude spectrum.		

	5.3	Realization diagram (Form I and II)		
6	**Self Study**	**State Space Model:** Procedure to determine state equations, State equations from transfer function, Laplace transform solution of state equations		**6***
			Total (*Not included)	**42**

Laboratory Component

Sr. No.	**Title of the Experiment**
1	Representation of Signals
2	Operations on Signals
3	Convolution on Continuous Time Signals
4	Synthesis of signals using Fourier Series
5	Synthesis of signals using Fourier Transform
6	Analysis of LTI system using Laplace Transform
7	Plotting of frequency spectrum
8	Butterworth filter design
9	Chebyshev filter design
10	Mini project: Analysis of real-world signals

Text Books

Sr. No.	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
1	Signals and Systems	3rd	Nagoor Kani	Tata McGraw Hill	2011
2	Digital Signal Processing	4th	Ramesh Babu	Scitech	2014

Reference Books

Sr. No.	**Title**	**Edition**	**Authors**	**Publisher**	**Year**
1	Signals and Systems	2nd	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab	Pearson	2002
2	Signals and Systems	3rd	Simon Haykin and Barry Van Veen	John Wiley & Sons	2002
3	Linear Systems and Signals	4th	B. P. Lathi	Oxford University Press	2005
4	Signals and Systems	2nd	H. P Hsu, R. Ranjan	Schaum's outlines	2006

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned				
		L	T	P	O	E	L	T	P	O	Total
(SBC)	Mini Project-I	0	0	0	4	4	0	0	0	2	2
		Examination Scheme									
EC208		Component			ISE		MSE		ESE		Total
		Theory			--		--		--		--
		Laboratory			--		--		--		--
		Self-Study			100		--		100		200

Pre-requisite Course Codes, if any.	
Course Objective: To apply engineering knowledge and propose innovative, sustainable solutions to the real-life challenges	
Course Outcomes (CO): At *the End of the course students will be able to*	
EC208.1	Discover potential research areas for addressing societal issues
EC208.2	Conduct a survey of basic and contemporary literature in the preferred field of study.
EC208.3	Formulate and propose a plan for creating a solution for the research plan identified.
EC208.4	Exercise the team building, communication and management for design and implementation of projects.
EC208.5	Compare and contrast the several existing solutions for research challenge
EC208.6	Report and present the findings of the study conducted in the preferred domain.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC208.1												
EC208.2												
EC208.3												
EC208.4												
EC208.5												

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
EC208.1						
EC208.2						
EC208.3						
EC208.4						
EC208.5						

Department of EXTC

BLOOM'S Levels Targeted (Pl. appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate√	Create

Pre-requisite Course Codes	All the Courses till third Semester

Mini project is an opportunity to make a difference in the experience of education in its own way. It is an attempt of scientific study of the problem in surrounding in order to guide, correct and evaluate the actions and decisions about it. It is based on a small project correlating scientific knowledge and day to day experience which encourages development of scientific attitude to solve real life problems among students.

The Objectives of Action Research are:

- ✓ To make students sensitive towards societal issues
- ✓ To learn scientific principles from day-to-day experiences
- ✓ To develop psycho-technological skills through observation, classification, statement of hypothesis etc.
- ✓ Development of communication, organizational skills and maturity through discussion, presentation etc.
- ✓ To develop ability to correlate science, technology and society
- ✓ To apply engineering knowledge and propose innovative, sustainable solutions to the real-life challenges

Steps for Implementation: (ISE: Through 2 Phases of Evaluation) and ESE

- ✓ Keen observation of the surrounding/society
- ✓ Identification of the problem
- ✓ Analysis of the problem
- ✓ Collection of relevant information by formulating research questions
- ✓ Suggesting plan of action
- ✓ Conducting experiments
- ✓ To draw conclusion
- ✓ To find the possible solution to rectify the problem
- ✓ To execute experiments and remedial measures wherever possible

Students can seek guidance from teachers, other experts and make effective use of other sources of information available around them. Students must ensure that problem to be solved in manageable in one semester.

Teachers must follow the below mentioned principles:

- ✓ Make student confront problem solving
- ✓ Develop methods and techniques of handling problems.
- ✓ Teach how to use the methods and not directly give solution to the problem.

- ✓ Lead the students to the peak of their powers for improvement of better learning.

The H/W and S/W resources required to complete the Mini-Project-I may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

- Learning additional skills
- Development of ability to define and design the problem and lead to its accomplishment with proper planning
- Learn the behavioral discipline by working in a team. The team may be maximum three (03) students.

Evaluation:

Project report should contain project title, student details, certificate and acknowledgements. Other sections of the report shall be decided by the department based on projects. But it must have introduction, necessity of project, objectives, hypothesis, plan, observations, and analysis of results, conclusion and references along with other sections related to technology. The ISE and ESE evaluation will be carried out based on the rubrics framed by the Department. The ESE marks will be based on final demonstration of the project and viva based on it and report/poster/technical paper of the project in the standard format provided by the Department.

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

Sem-V

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Analog and Digital Communication	3	0	2	6	11	3	0	1	4
		Examination Scheme								
EC301		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC202: Electronic Devices MA203: Probability and Stochastic Processes EC207: Signals and Systems
Course Objective: The objective is to equip the students with basic knowledge for analyzing analog and digital communication systems ranging from data networks and internet to mobile data communication systems such as cellular and Wi-Fi systems. Specifically, the students will learn how to manage communication system resources including bandwidth and power by selecting a proper signaling and/or analog/pulse/digital modulation scheme	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC301.1	Describe various entities of analog, pulse, and digital communication system.
EC301.2	Apply concepts of signals and systems to analyze behavior of modulated signals in time domain, frequency domain and signal space.
EC301.3	Analyze and computer system performance measures such as efficiency, bit rate and bandwidth of various analog, pulsed and digital modulation methods.
EC301.4	Analyze the behavior of a various analog, pulse, and digital modulation schemes in presence of noise.
EC301.5	Compare various modulation and demodulation techniques.
EC301.6	Examine various wired and wireless applications and further infer health, safety, and environment aspects of wired and wireless systems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC301.1	3				-				-	-		1
EC301.2	2	2			3				3	3		
EC301.3	2	2			3				3	3		1
EC301.4	3	3			3				3	3		1
EC301.5	2	2			3				3	3		
EC301.6	1	1				1	1	1	3	3		3

Department of EXTC

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC301.1	2	2				
EC301.2	2	2		2	1	
EC301.3	2	2		2	1	
EC301.4	2	2		2	1	
EC301.5	2	2				
EC301.6	1	1				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Continuous-Wave Modulation**	1,2	10
	1.1	Review of signals and systems, Frequency domain representation of signals, classification of Frequency spectrum, Block diagram of an analog and digital communication system, Need for modulation.		
	1.2	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations, Principle of FDM.		
	1.3	Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.		
	1.4	Super heterodyne receiver		
	1.5	Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.		
2	Title	**Pulse Modulation**	1,2	08
	2.1	Sampling process. Types of Pulse modulation		
	2.2	Pulse code modulation (PCM), Differential pulse code modulation.		
	2.3	Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers		
3	Title	**Baseband Pulse Transmission**	1,2	10
	3.1	Baseband receiver, Probability of error of integrate and dump receiver, Matched filter, optimum filter		
	3.2	Line coding and Power spectral density (PSD) of line codes, inter symbol Interference and Nyquist criterion, Raised cosine filter,		
	3.3	Duobinary encoding, Introduction to linear and adaptive		

		equalization		
4	**Title**	**Pass band Digital Modulation schemes**	2	**14**
	4.1	BPSK, DPSK, QPSK, M-ary PSK, QAM, BFSK, M-ary FSK, MSK- Principle of working, PSD, and Signal space analysis		
	4.2	Digital Modulation tradeoffs, Probability of Error evaluations of various modulations. (Derivation not expected)		
	4.3	Synchronization and Carrier Recovery for Digital modulation.		
	4.4	Introduction to OFDM		
5	**Self-Study**	**a. Case study (anyone)** 1. Effect of various Communication systems on health, safety, and environment. 2. Professional engineering regulations, legislation and standards related to communication. 3. Code of ethics for wired and wireless systems for user/devices/companies **b. Research article (anyone)** 1.Applications of analog and digital modulations 2.Digital modulations specifications and effect of various parameters in wireless networks such as WLAN 3.Software defined radio for digital communication 4. Error correction codes for digital communication 5.Comparative analysis of analog and digital communication through applications		**06**
			Total	**42+6**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	**Title of the Experiment**
1	Simulation and implementation of double sideband full carrier for various modulation index.
2	Implement the frequency modulation circuit to obtain FM waveforms and calculate modulation index
3	Analyze effect of pre-emphasis and de-emphasis on FM waveforms.
4	Implementation of natural sampling and reconstruction of waveforms
5	Implementation and detection of pulse amplitude modulation.
6	Implementation of Binary Phase Shift Keying.
7	Implementation of Binary Frequency shift keying.
8	Duo binary Encoder.
9	Simulation of digital modulation scheme and analysis of Power spectral density.
10	Simulation and analysis of signal space of various modulations in presence of noise.

11	Signal transmission through Raised cosine filter and eye pattern analysis.
12	Simulation of OFDM.
13	Mini project in analog/pulse/digital modulation methods.

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Communications Systems	Fourth	Haykin S	John Wiley and Sons	2001
2	Principles of Communication Systems	Second	Taub H. and Schilling D. L	Tata McGraw Hill	2001

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Communication.	Third	Haykin S	John Wiley and Sons	2001
2.	Communication Systems Engineering	Fourth	Proakis J. G. and Salehi M.	Pearson Education	2002
3.	Digital and Analog Communication	Fourth	B.P.Lathi	Oxford	2017

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Control Systems	3	0	2	6	11	3	0	1	4
		Examination Scheme								
EC302		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis EC 101: Digital Systems and Microprocessors EC 203: Probability and Stochastic Processes EC 204: Electronic Instruments and Measurement Lab
Course Objectives: To develop a system for real life application by applying the concepts of control system theory and allied techniques for system performance evaluation.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC302.1	Classify different types of control systems, component of control system and formulate mathematical modeling of the given system.
EC302.2	Apply various methods for representation of the given control system.
EC302.3	Analyze the transient and steady state behavior of given system for standard test inputs.
EC302.4	Analyze the stability of systems in time domain and frequency domain.
EC302.5	Discuss the concept of controllability and observability using state variable model.
EC302.6	Evaluate the system performance with the use of compensators & controllers.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC302.1	3				2			3	3	2	2	2
EC302.2		3			2			3	3	2	2	2
EC302.3		3			2			3	3	2	2	2
EC302.4		3			2			3	3	2	2	2
EC302.5		3			2			3	3	2	2	2
EC302.6	3				2	2		3	3	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC302.1	1	1	2		-	
EC302.2	1	1	2		-	
EC302.3	1	1	2		2	
EC302.4	1	1	2		2	
EC302.5	1	1	2		2	
EC302.6	1	1	2		2	

Department of EXTC

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to control system and system Modeling**		10
	1.1	**Introduction to control system:** Definition of system, Notion of feedback, Open loop and closed loop systems; feedback and feed forward control structure; Examples of control systems.	1,2	
	1.2	**Dynamic Response:** Standard test signals; Transient and steady state behavior of first and second order systems; Generalized error coefficients, steady state errors in feedback control systems and their types.	1,2	
	1.3	**Control System Modeling:** Types of model's Impulse response model, State variable model, Transfer function model, Modeling of electrical systems and translational mechanical systems.	1,2	
2	Title	**Representation of Control System and State Space Analysis**		10
	2.1	Block diagram representation of systems, Block diagram reduction methods, closed loop transfer function, signal flow graph. Mason's gain rule	1,2	
	2.2	**State Space Analysis:** Concepts of state space, State equations, State transition matrix, properties of state transition matrix, Solution of homogeneous systems.	1,2	
	2.3	**Controllability and Observability:** Concept of controllability, Controllability analysis of LTI systems, Concept of observability, Observability analysis of LTI systems using Kalman approach.	3,4	
3	Title	**Time Domain System Stability Analysis**		8
	3.1	Concepts of Stability Concept of absolute, relative and robust stability	1,2	
	3.2	Routh-Hurwitz stability criteria	1,2	
	3.3	**Root Locus Analysis:** Root-locus concepts; General rules for constructing root-locus, Root-locus analysis of control systems.	1,2	
4	Title	**Frequency Domain System Stability Analysis**		8
	4.1	Relation between time and frequency response	1,2	
	4.2	**Bode Plot:** Magnitude and phase plot, Method of plotting Bode plot; Stability analysis by using Gain and phase margins on the Bode plots	1,2	
	4.3	Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	1,2	
5	Title	**Compensators & Controllers**		6

	5.1	Types of compensators, Realization of basic compensators – cascade compensation in time domain and frequency domain.	1,2	
	5.2	**Controllers**: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers.	1,2	
	5.3	**Advanced Control Systems:** Introduction to Robust Control, Adaptive control and Model predictive control, Neuro- fuzzy controllers.	3,4	
6	**Self-Study**	Examples on open loop and closed loop control system, Modeling of rotational mechanical systems, Pole placement using state feedback Popov–Belevitch–Hautus (PBH) test in state space, Design of lag, lead and lag-lead compensator using Bode plot and Root locus techniques, Design of real-life applications of control system.	1,2,3, 4,5	
			Total	**42**

Laboratory Component:

Exp. No.	Experiment Details	Marks CO
1	To obtain the characteristics of control system components: i. To plot the Synchro transmitter characteristics and Synchro transmitter and receiver as an error detector. ii. To plot characteristics of Potentiometer and its loading effect for different conditions of load.	05 CO1
2	To demonstrate the working of real-life feedback control system and obtain their characteristics: i. To plot Speed torque characteristic of DC servo motor. ii. To determine the line and load regulation characteristics of AC servo voltage stabilizer at different line and load conditions and observe the mechanism of AC voltage stabilization as an example of closed control system.	05 CO1
3	To develop a program in Matlab/Scilab/LabVIEW: i. To define the given closed loop transfer functions of system and plot their poles & zeros on s-plane. ii. To reduce the given control system block diagram or signal flow graph.	05 CO2
4	To develop a program in Matlab/Scilab/LabVIEW: i. To obtain the step response of a given first/second order control system and obtain its time domain parameters from this step response. Compare these results with mathematical calculations. ii. To determine step response for a Type 0, Type 1, Type 2 systems and find error coefficients. iii. To find solution for a given control system described by its state space equation in terms of state transition matrix, zero input response, zero state response, complete response.	10 CO3
5	Develop a program in Matlab/Scilab/LabVIEW:	10 CO4

	i. To obtain the root locus of a system described by its Transfer Function with unity feedback, Comment on the stability of this given control system. Compare these results with mathematical calculations. ii. To find gain margin and phase margin of the system described by its Transfer Function with unity feedback using Bode/Nyquist plot. Comment on the stability of this given control system. Compare these results with mathematical calculations.	
6	Develop a program in Matlab/Scilab/LabVIEW: i. To find whether a given control system described by its state space equation is controllable or not, observable or not, to find rank of matrix and using rank comment on system controllability and observability. ii. To design a controller and observer via state space.	10 CO5
7	Evaluate the effect of Compensator/PID controller on performance of the control system.	5 CO6

ISE Evaluation: CO1-CO6

Mini-Project: Identify the model of control system for real life application and demonstrate controlling action for the same.

This is group activity. Students will form a group of minimum 3 students. Students will develop the block diagram of the system first, then design each block using appropriate components. Simulate the complete block diagram using any tool like Matlab, Scilab or LabVIEW. The duration of this activity is a complete semester, but evaluation will be done in phases and rubrics designed. In the first phase students will develop the block diagram for the given problem statement. In the second phase students will develop the block diagram and simulate each of the block diagrams and test it for input-output relationship. In the third phase students will interface all the designed blocks to obtain final input-output relationship of the system. Hardware implementation is optional.

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Control Systems Engineering	Fifth	I. J. Nagrath, M. Gopal	New Age International	2012
2	Modern Control Engineering	Fifth	Ogata. K	Prentice Hall of India	2010

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Control Systems: Principle and design	First	M. Gopal	Tata McGraw Hill	1998
2	Modern Control System	Eleventh	Richard C. Dorf and Robert H. Bishop	Pearson	2013
3	Control Systems Engineering	Sixth	Norman Nise	John Wiley & Sons	2011
4	Linear Control System Analysis and Design: Conventional and Modern	First	Constantine H. Houpis and Joh n J. D'Azzo	Mcgraw-Hill	1975

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Digital Signal Processing	3	0	2	5	10	3	0	1	4
		Examination Scheme								
EC303		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC207: Signals and Systems
Course Objective: To develop mathematical foundation of system and design digital filters	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC303.1	Classify and perform various operations on signals and systems.
EC303.2	Apply DFT properties and illustrate FFT algorithms.
EC303.3	Apply Z Transform on discrete time signals.
EC303.4	Analyze LTI System using Z Transform.
EC303.5	Design and Realize Digital filters.
EC303.6	Analyze Multirate Signal Processing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC303.1	3	1	2		2							
EC303.2	1	1	2		2							
EC303.3	1	1	2		2							
EC303.4	1	1	2		2							
EC303.5	1	1	2		2							
EC303.6	1	1	2		2							**2**

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC303.1		2				2	
EC303.2		2				2	
EC303.3		2				2	
EC303.4		2				2	
EC303.5		2				2	
EC303.6		1				2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Overview of Discrete Time Signals**	6,7,8	**08**
	1.1	Sampling of Continuous Time Signal, Standard Discrete Time Signals: Impulse Signal, Unit Step, Unit Ramp, Sinusoidal, Exponential.		
	1.2	**Classification of Signals:** Deterministic and non-deterministic, Periodic and a periodic, Symmetric (even) and Asymmetric (odd), Energy and Power, Causal and Anti-causal signals.		
	1.3	**Operations of Signals:** Shifting, Scaling, Time Reversal, Addition and Multiplication, Convolution (Linear and Circular), Correlation		
2	**Title**	**Discrete Fourier Transform (DFT)**	1, 3	**12**
	2.1	Discrete Time Fourier transform (DTFT), Discrete Fourier Transform (DFT), Properties of DFT, Inverse DFT.		
	2.2	**Fast Fourier Transform:** Radix-2 Decimation in Time Fast Fourier Transform (DIT-FFT) and Decimation in Frequency Fast Fourier Transform (DIF-FFT) algorithms, Real and Complex Calculations using FFT, Linear and Circular Convolution using FFT,		
	2.3	Filtering of long data sequence, Overlap Add Method, Overlap Save Method		
3	**Title**	**Z-Transform**	6,7	**04**
	3.1	Z-Transform of discrete time signals, Properties of Z-Transform, Relation between Z-Transform and DTFT,		
	3.2	Inverse Z-Transform, Long division Method, Partial Fraction Expansion Method		
4	**Title**	**Linear Time Invariant (LTI) Systems**	1,4	**08**
	4.1	**Classification of systems:** Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems.		
	4.2	Impulse Response, Transfer Function, Differential Equation, Stability of Systems, Frequency Response, Solution of Differential Equation using Z-Transform		
	4.3	LTI systems as frequency-selective filters like; Low pass, High pass, Band pass, Invertibility of LTI systems, Minimum-phase, Maximum-phase, Mixed-phase systems		
5	**Title**	**Design of Digital filters and Implementation**	1,2	**10**
	5.1	Design of Infinite Impulse Response (IIR) filters using Impulse Invariant Method and Bilinear Transformation Method, Butterworth and Chebyshev Type I filter design.		

	5.2	Concepts of Finite Impulse Response (FIR) filter, symmetric and anti-symmetric FIR filter, FIR filter design using Window method and Frequency sampling method.		
	5.3	Realization structures for IIR and FIR filters using direct Form Realization, cascade, parallel structures; Linear Phase Realization, Frequency Sampling Realization.		
6	**Self-Study**	1.**Multirate Signal Processing:** Down-sampling and Up-sampling by integer factors; Decimator and Interpolator, Sampling rate conversion by non-integer factor. 2. **Application of Filter**: Sub-band filters.	1,5	***5**
			Total	**42+*5**

Laboratory Component

Sr. No	Title of the Experiment
1	Discrete Convolution and Correlation
2	Discrete Fourier Transform
3	Fast Fourier Transform
4	Linear Filtering using Overlap Add Method/ Overlap Save Method.
5	Design of Butterworth IIR Filter using Impulse invariant method
6	Design of Butterworth IIR Filter using Bilinear Transformation method
7	Linear phase FIR Filter design using Windowing method
8	Linear phase FIR Filter design using Frequency sampling method
9	Multirate Signal Processing
10	Mini Project on real Time DTSP application

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing: Principles, Algorithms and Applications	Fourth	J. Proakis, D. G. Manolakis, and D. Sharma	Pearson Education	2014
2	Digital Signal Processing	Fourth	Ramesh Babu	Scitech	2014
3	Digital Signal Processing	-	S. Salivahanan, A Vallavaraj, C Gnanapriya	Tata McGraw Hill	2010

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Signals and Systems	Second	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab	Pearson	2002
2	Signals and Systems	Third	Simon Haykin and Barry Van Veen	John Wiley & Sons	2002
3	Theory and Applications of Digital Signal Processing	Second	L. R. Rabiner and B. Gold	Prentice-Hall	2006
4	Multirate Systems and Filter Banks	First	P. P. Vaidyanathan,	Pearson	1992

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Electromagnetic Engineering	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC304		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis MA201: Linear Algebra
Course Objective: To teach fundamentals of Electromagnetic Waves	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC304.1	Apply basic laws of electromagnetic and Maxwell's equations.
EC304.2	Illustrate the behavior of EM waves and travelling of waves in free space as well as media.
EC304.3	Solve problems related to the propagation of electromagnetic waves.
EC304.4	Discuss the types of antennas and their parameters.
EC304.5	Discuss types of radio wave propagation.
EC304.6	Design applications using Electromagnetic Waves theory.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC304.1	1	1	2		2					3		
EC304.2	1	1	2		2							
EC304.3	1	1	2		2					3		
EC304.4	1	1	3		2					1		
EC304.5	1	1	2		2							
EC304.6	1	1	3		2					2		3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC304.1		2			2	
EC304.2		2			2	
EC304.3		2			2	
EC304.4		2			2	
EC304.5		2			2	
EC304.6		1			1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Coordinate system transformation and vector calculus**		3
	1.1	Cartesian, cylindrical and spherical coordinate, Differential length, area and volume, line surface and volume integrals.	2	
	1.2	Del Operator, Gradient of scalar, Divergence of a vector and Divergence Theorem, Curl of a Vector and Stoke's Theorem, Laplacian Theorem, Classification of a Vector Field.		
2	**Title**	**Basic Laws of Electromagnetic and Maxwells Equations**	1	9
	2.1	Coulombs law, Electric fields due to continuous charge distributions, Gauss law and its applications, Electric potential (Magnetic vector potential and Electrical Scalar Potential), relationship between E and V, Poisson and Laplace equations, Bio-Savarts law, Amperes law.		
	2.2	Boundary conditions for static electric and magnetic fields		
	2.3	Faradays Law, Displacement current, Maxwells Equations: Integral and differential form for static and time varying fields and its interpretation		
3	**Title**	**Electromagnetic Wave Propagation**	1,2	9
	3.1	Wave equation: Derivation and its solution in Cartesian co-ordinates.		
	3.2	Solution of wave equations: Partially conducting media, perfect dielectrics and good conductors, Concept of Skin Depth.		
	3.3	Electromagnetic Power: Poynting Vector and power flow in free space and in dielectric, conducting media.		
	3.4	Polarization of wave: Linear, Circular and Elliptical.		
	3.5	Propagation in different media: Behavior of waves for normal and oblique incidence in dielectrics and conducting media.		
4	**Title**	**Waveguide**	1,2	6
	4.1	Wave propagation in parallel plane waveguide (No derivation expected), Analysis of waveguide general approach (No derivation expected), in waveguide.		
	4.2	Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation.		
5	**Title**	**Transmission Lines**	1,2	9
	5.1	Power frequency lines: Representation, losses and efficiency in power lines, effect of length, calculation of inductance and capacitance.		
		Radio frequency lines: Representation, propagation constant, attenuation constant, phase constant, group velocity, input		

		impedance, characteristic impedance, trade-off between attenuation and power transfer, reflection coefficient, standing wave ratio, VSWR, ISWR, ABCD parameters of transmission line.		
	5.2	Smith Chart: Impedance locus diagram, impedance matching.		
6	**Title**	**Applications of Electromagnetics**	2,3	6
	Self-Study	Xerography. Laser printer, Faraday's cage, lightning, RF MEMS, Magnetic levitation, Metamaterials, RFID, Stealth aircraft, remote sensing, radio astronomy, EMI and Electromagnetic Compatibility, Different types of antennas.	1,2,6	06
Total				**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	**Basic operations on scalar and vectors** Working with Numbers: Scalars and Vectors using any simulation platform or Python. Working with Complex Numbers using any simulation platform or Python. Working with Matrices using any simulation platform or Python.
2	**Curl and Divergence** Numerical Computation of Divergence and Curl. Numerical Computation of Divergence and Curl for a Current Carrying Wire.
3	Write a program that displays the distribution of the electric potential due to an electric dipole with a moment located at the origin of a spherical coordinate system.
4	Numerical Integration and Calculating the Electric Field from a Ring of Charge.
5	3-D and 2-D radiation patterns of a Hertzian dipole using MATLAB/Python.
6	**Antenna parameters** Visualization of a wireless system with two antennas. Radiation patterns of a small loop antenna. Radiation patterns of a quarter-wave monopole.
7	**Waveguide:** Verify the relationship between wavelength of an EM wave in air and inside a rectangular waveguide.
8	Simulating the Two-ray Propagation Model in any simulation platform or Python.
9	**Using Virtual Lab: Introduction** to Smith chart and its application for the unknown impedance measurement using virtual lab IIT K
10	Measurement of Frequency and wavelength of a waveguide using Microwave bench setup.
11	**Using Virtual Lab: Study** of field pattern of various modes inside a rectangular waveguide using virtual lab IIT K
12	**Case Study-** The student is required to develop a simple tool to carry out unit conversions that are associated with EM-related calculations.

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Textbooks:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Electromagnetic Waves	Third	R. K. Shevgaonkar	Tata McGraw Hill	2009
2	Principles of Electromagnetics	Sixth	Matthew N.O. Sadiku	Oxford International Student	2015

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Engineering Electromagnetics	Third	W.H. Hayt, and J.A. Buck	McGraw Hill	2006
2	Electromagnetic Waves and Radiating Systems	Second	Edward C. Jordan and Keth G. Balmin	Pearson Publications	2006
3	Engineering Electromagnetics	Third	Nathan Ida	Springer Publications	2015
4	Antennas & Wave Propagation	Fourth	J.D. Kraus, R.J. Marhefka, and A.S. Khan	McGraw Hill	2011

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SBC)	Java Programming Lab	0	1	2	2	5	0	1	1	2
		Examination Scheme								
		Component	ISE		MSE		ESE (%)			Total
EC305		Theory	100*		--		--			100
		Laboratory	50		--		50#			100

Pre-requisite Course Codes, if any.	CS101: Problem Solving using Imperative Programming CS102: Problem Solving using OOPs
Course Objective: To learn Object-Oriented programming paradigm using Java programming language**.**	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC305.1	Demonstrate programming using basic constructs of JAVA.
EC305.2	Apply Inheritance and polymorphism for a given scenario.
EC305.3	Apply abstraction and exception handling to create an efficient program.
EC305.4	Use Generic classes and collection for solving problem.
EC305.5	Develop a mini project based on the real-world problem.

Note:

*= Tutorial-50 marks and Mini Project-50 marks (Preferably based on real-world problem statement from Industry/Academia/Research)

#= oral exam-20 marks and Lab experiment-30 marks

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC305.1	3				2							2
EC305.2	2				2							2
EC305.3	2				2							2
EC305.4	2				2							2
EC305.5	2	1	1	1	2	1			2	2		2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC305.1		2		2		
EC305.2		2		2		
EC305.3		2		2		
EC305.4		2		2		
EC305.5		2		2		

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to JAVA**	1,2,3	3
	1.1	Fundamentals of Java Programming: Classes, JDK, JRE, JVM, Unicode system, I/O using Scanner class and Buffered Reader class.		
	1.2	Instance variables, Methods, Constructors.		
	1.3	Object class, Nested class, Access Specifiers, Abstract Classes and Wrapper Classes.		
2	Title	**OOP Concepts Mapping to JAVA**	1,2,3	4
	2.1	Inheritance (IS – A), Aggregation & Composition (Has – A) Method overloading & overriding, this, super, final keyword, Static.		
	2.2	Auto boxing and Un boxing, Polymorphism.		
	2.3	Packages and Interfaces: Package concept, creating user defined package, Access control protection, Interface.		
3	Title	**Exception Handling and Multithreading**	1,2,3	4
	3.1	Try and catch block, Multiple catch block, Nested try, finally block, Throw, Throws keywords, Exception propagation, Custom exception.		
	3.2	Create thread using Thread and Runnable class. Thread methods, schedule, sleep, join, Thread priority, Thread group, perform multiple tasks using multiple thread Thread synchronization.		
4	Title	**Generics and Collection**	1,2,3	3
	4.1	Creating Generic Classes, Generic Methods, Bounded Type		
	4.2	Collection's framework, methods of collection interface (Array list, Linked list, Queue etc.)		
			Total	**14**

Laboratory Component, if any.

Sr. No	Title of the Experiment
1	Program on I/O using command line arguments, scanner class, Buffered Reader etc.
2	Program on Constructor, types of constructors and constructor overloading.
3	Program on Polymorphism, Runtime polymorphism.
4	Program on Inheritance, Abstract Class, Interface.
5	Program on Nested Class, Aggregation, Composition.

6	Program on Multithreading.
7	Program on Exception Handling. (built in and User defined)
8	Program on Package and access modifiers.
9	Program on Generics
10	Program on Collection

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Java Programming from the Group Up	First	Ralph Bravaco, Shai Simoson	Tata McGraw-Hill	2009
2	Java The Complete Reference	Eleventh	Herbert Schildt	Tata McGraw-Hill	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	An introduction to Programming and Object-Oriented Design using Java	Third	Jaime Nino, Frederick A. Hosch	Wiley Student Edition	2008
2	Java Programming A Practical Approach	First	C Xavier	Tata McGraw-Hill	2011
3	Java™ Programming Language	Fourth	Ken Arnold, James Gosling, David Holmes	The (Java Series) by Sun	2005

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

Sem-VI

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Fundamentals of Antenna	3	0	2	6	11	3	0	1	4
		Examination Scheme								
EC306A		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide a fundamental understanding of Antennas	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC306A.1	Calculate the fundamental parameters of Antenna.
EC306A.2	Describe fundamental theory of antennas.
EC306A.3	Select antenna based on applications.
EC306A.4	Evaluate antenna based on applications.
EC306A.5	Design Antenna Arrays.
EC306A.6	Design antenna based on given requirements.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC306A.1	2	3						2	2	2		
EC306A.2	2	3						2	2	2		
EC306A.3		2						2	2	2		
EC306A.4		2		2				2	2	2		
EC306A.5		2		2				2	2	2		
EC306A.6	2	1						2	2	2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC306A.1		2				-	
EC306A.2		2				2	
EC306A.3		2				2	
EC306A.4		2				2	
EC306A.5		2				2	
EC306A.6		1				1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1 (CO1)		**Fundamental Concepts:**	1	08
	1.1	Introduction, types of Antennas, Radiation mechanism, Poynting vector, Steradian concept, Power intensity		
	1.2	Antenna Parameter: Radiation pattern, Radiation power density, Radiation Intensity, Gain, Directivity, HPBW, FNBW, Beam efficiency, Bandwidth, Polarization, Input Impedance, Reflection coefficient, Return loss, VSWR, Antenna Efficiency, Effective Aperture, Communication link and Friis transmission equation.		
2 (CO2, CO3)		**Radiation from wires and loops**	1	10
	2.1	Introduction, Infinitesimal dipole: Radiation zones, Total radiated power, Radiation resistance, Directivity, Effective area, short dipole, Finite-length dipole: Radiated power, Radiation resistance, Directivity, Effective area, Half-wave dipole and its properties, Loop antenna.		
3 (CO3, CO4)		**Aperture Antennas**	1	06
	3.1	Introduction, Field equivalence principle, Love's equivalence principle, Electrical and magnetic conductor equivalence principle, Computation of field quantities of aperture antenna, Relation between wire and aperture antennas, Horn antenna design principle.		
4 (CO5)		**Antenna Arrays**	1	10
	4.1	Introduction, Two-element array, Example problems, Pattern multiplication concept, N-element array, Uniform array, Array factor, Broad-side and end-fire arrays, Phased array, Directivity and pattern characteristic of linear uniform array, non-uniform array, Binomial array, Dolph-Chebyshev array concept, Design principle of Chebyshev array and examples, Planar arrays		
5 (CO6)		**Microstrip Antennas**		
	3.1	Introduction: Rectangular Patch, Circular Patch, Parametric study, Circularly polarized antennas, Axial Ratio, MSA suspended Configuration.	1,4	08
	3.2	MSA Arrays and Feed Networks, Corporate and Series Feeds		
6 (Self Study)		**Advanced Antennas:** Reflector antenna, Dielectric Resonator antenna, Metamaterial based antennas, Wearable antenna, Reconfigurable antennas, Ultra-wideband antennas, Smart Antennas		06
			Total	**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Department of EXTC

Sr. No	Title of the Experiment
1	Design a Dipole Antenna using HFSS
2	Design a monopole Antenna using HFSS
3	Design a Horn Antenna using HFSS
4	Design a Helical Antenna using HFSS
5	Design a Microstrip Patch Antenna
6	To calculate and infer various fundamental parameters of antenna like radiation pattern, Radiation power density, Radiation Intensity, Gain, Directivity, HPBW and FNBW using Scilab.
7	To calculate the power delivered to the Receiver Antenna.
8	To design a Pyramidal Horn Antenna in E-plane and H-plane
9	To show Pattern Multiplication phenomena in an Antenna using two infinitesimal dipoles.
10	To design Array factor pattern of N-element of uniform amplitude of Broadside Array.
11	To design Array factor pattern of N-element of uniform amplitude of End-fire Array
12	To design Array factor pattern of N-element of non-uniform amplitude of Broadside / End-fire Array using Binomial Array method.
13	To design Array factor pattern of N-element of non-uniform amplitude of Broadside /End-fire Array using DolphTschebyscheff Array method.

Textbooks:

S. N.	Title	Authors	Edition	Publisher	Year
1	Antenna Theory: Analysis and Design	Constantine A. Balanis	Fourth	Wiley	1982

Reference Books:

S. N.	Title	Authors	Edition	Publisher	Year
1	Antennas & Wave Propagation	J.D. Kraus, R.J. Marhefka, and A.S. Khan	Fourth	McGraw Hill	2011
2	Handbook of Microstrip Antennas	R. James and P.S. Hall	Third	Peter Peregrinus	1989
3	Antennas and Radio Wave Propagation	R. E. Collin	Fourth	McGraw-Hill	1985
4	Broadband Microstrip antennas	Girish Kumar and K. P. Ray	First	Artech House	2003

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Power Electronics	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component			ISE		MSE		ESE	Total
EC306B		Theory			75		75		150	300
		Laboratory			50		--		50	100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To impart knowledge on the basic topology, operation and analysis using performance parameters of power electronic converters.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC306B.1	Understand the operation of power semiconductor switches.
EC306B.2	Analyze various single and three phase AC-DC power converter circuits
EC306B.3	Illustrate the operating principle and construct a various type of DC-DC converters.
EC306B.4	Analyze various single and three phase DC-AC power converter circuits
EC306B.5	Understand the operation of AC-AC voltage converters by means of circuit topology and waveforms.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC306B.1	2.5											
EC306B.2	2	3										
EC306B.3		2										
EC306B.4		2.5	2.5									
EC306B.5	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO/PEO/PSO	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC306B.1	2	1				
EC306B.2	2			2		
EC306B.3	2			2		
EC306B.4	2			2		
EC306B.5						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Power Semiconductor Devices**		
	1.1	Principle of operation, constructional features, characteristics of: SCR, GTO, MOSFET and IGBT, Si-Carbide-MOSFET and IGBT, Ga-Ni Power devices, Common type of Power Modules	T1, T3	**6**
	1.2	Basic Gate Drive circuits for SCR, MOSFET and IGBT		
2	**Title**	**AC to DC Converters**		
	2.1	Operation and analysis of single-phase controlled rectifiers with R, and RL load, freewheeling effect. Operation and analysis of three-phase controlled rectifiers with resistive load, effect of source inductance,	T1, T2, R4	**10**
	2.2	Single Phase and Three-Phase PWM Rectifier, Vienna Rectifier. Power factor improvements	T1, R4	
3	**Title**	**DC to DC Converters**		
	3.1	Switch Mode Power Converters, non-isolated and isolated converters, Buck, Boost and Buck-Boost converters, flyback and forward converters, Hardware design of SMPS converters and their Magnetics	T1, R4	**10**
	3.2	Closed loop control of Switched Mode DC-DC Converters with Constant Voltage and Constant Current mode of Operation	R5	
4	**Title**	**DC to AC Converters**		
	4.1	Principle of operation of Inverters, Inverter Classification.	T1,	
	4.2	Voltage source inverters: -Principle of operation and analysis of: Single phase Half bridge, full bridge, and three-phase bridge inverters, six step operation (R-Load), PWM control of Voltage source converters. Introduction to Space Vector Modulation	T2, R4	**10**
5	**Title**	**AC–AC converters**		
	5.1	Principle of on-off and phase control – single-phase half and full wave AC voltage controller, three-phase AC voltage controller. Single Phase Bidirectional AC switches using MOSFETs, IGBTs, Single-phase Bidirectional AC-AC converters	T2 R6	**6**
6	**Self Study**	Comparison of Power Semiconductor Devices, Detailed analysis of minimum one application for each type of converter (AC-DC, DC-AC, DC-DC)		**6***
			Total (*not included)	**42**

Department of EXTC

Laboratory Component (Indicative): To be completed minimum of 8 to 10 experiments

Sr. No	Title of the Experiment
1	Study of Characteristics and Specification of SCR, MOSFET/ IGBT
2	Gate Driver Circuits for SCR, MOSFET, IGBTs
3	Single phase Line Commutated Semi-converter and Fully controlled Converter
4	Single phase PWM Vienna Rectifier
5	Operation and analysis of single- phase bridge inverter with R Load and controllable Switches
6	Demonstration of PWM three phase bridge Voltage Source inverter with L-C filter
7	Design and Demonstration of a Buck-Converter and Boost Converter in CCM
8	Design and Demonstration of a flyback-Converter
9	Design and Demonstration of single-phase AC Voltage Controller using Thyristors
10	Simulation Exercise on PWM Vienna Rectifier
11	Simulation Exercise on Single-phase PWM AC-AC converters with Bidirectional switches

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Power Electronics: converters, Application, and design	Third	Ned Mohan, Undeland and Robbin	John Wiley and sons	2003
2	Power Electronics Circuits, Devices and Applications	Fourth	Rashid M.H.	Pearson Education	2004
3	Power Electronics	Second	MD Singh and K.B Khanchandani	Tata McGraw Hill	2006

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Power Electronics and AC Drives	First	Bimal K Bose	Pearson Education Asia	2002
2	Modern Power Electronics	Second	P.C Sen	S.chand	2005
3	Power Electronics	Eleventh	P.S.Bimbra,	Khanna Publishers	2003
4	Power Electronics	First	S. K. Mandal	McGraw Hill Education (India)	2014
5	Switch-mode power converters	First	Keng C. Wu.	Elsevier Inc.	2006,
6	Advanced Power Electronics Converters	First	EUZELI CIPRIANO DOS SANTOS JR., EDISON ROBERTO CABRAL DA SILVA	John Wiley & Sons	2015

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Computer Communication Networks	3	-	2	6	11	3	-	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC307		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC301: Analog and Digital Communication
Course Objective: The objective of the course is to provide a fundamental understanding of ComputerCommunication networks.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC307.1	Apply Conceptual understanding and functional aspects of computer communication and telecom networks.
EC307.2	Analyze design and configure small and medium sized computer network that meets a specific need for communications.
EC307.3	Simulate computer networks and analyze the simulation results including troubleshoot connectivity problem occurring at layers of TCP/IP model.
EC307.4	Apply the principles behind the Modern Network approaches such as SDN NFV and IoT and security issues.

CO-PO Correlation Matrix: (1-Weak, 2-Medium, 3-Strong)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC307.1	3	3										
EC307.2			3	2	3							2
EC307.3			3		3	2						
EC307.4	2	2							3	3		3

CO-PEO/PSO Correlation Matrix: (1-Weak, 2-Medium 3-Strong)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC307.1		2				
EC307.2		2		3		
EC307.3		2			3	
EC307.4		2				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze√	Evaluate√	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Fundamental of Computer Networks**	1	08
	1.1	Basic definitions. Networking devices. Layering architecture: The OSI model. Description of layers.		
	1.2	The Internet protocols TCP/IP protocol suit, IP Protocol, and address. What is the Internet? Delay on the Internet (trace route and ping). History of the Internet. Security on the Internet.		
2	**Title**	**Enterprise Network Design**	2	06
	2.1	Network requirements, Planning and Design, Structured Wiring and Structured Network Design consist of Core Layer, Distribution Layer, and Access.		
	2.2	Network Design methodology &Network Design considerations Co re Layer Technologies.Investigating Server Farms and Security Inte grating, Remote Sites into the Network Design.		
3	**Title**	**Transport and Application Layer**	1,3	06
	3.1	Transport Protocols introduction. Reliable data transfer - Stop-and-wait and Go-back-N design and evaluation. TCP and UDP semantics and syntax. TCP RTT estimation. Principles of congestion control - efficiency and fairness, reactive and proactive. Socket's programming A simple client-server implementation.		
	3.2	Application layer: Application layer protocols, Client-server as a key model. Web, HTTP, FTP, SMTP, POP3, and DNS. Peer-to-peer files sharing networks.		
4	**Title**	**Software Defined Network and Network Function Visualization**	5	10
	4.1	Network Requirements - The SDN Approach - SDN- and NFV-Related Standards - SDN Data Plane - Open Flow Logical Network Device - Open Flow Protocol - SDN Control Plane Architecture - REST API - SDN Application Plane Architecture.		
	4.2	NFV Concepts - NFV Reference Architecture - NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration - NFV Use Cases - SDN and NFV		
5	**Title**	**Internet of Things (IoT) SECURITY**	1,3	10
	5.1	Threats and attacks. Symmetric and public key cryptography. IPsec-Authentication Header-Encapsulating security payload,		
	5.2	Secure sockets-Secure Socket Layer (SSL) - Firewalls and Internet access- Packet filter firewall- Proxy firewall- VPNs – Mobile IP – Header Compression – Voice over IP –		
	Title	**Networks**		5
6	Self-Study	Types of Networks, Transmission media, Network Topologies		
			Total	**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Network Lab set up
2	IP Networking & Network Commands: ipconfig, ping, trace route, net stat, arp, ns lookup dig & route etc.
3	Network Protocol Analyzers: TCPDUMP & Wire shark
4	Installation & Configuration of Web Server (at least four) using open-source tool
5	Network Socket Programming
6	Installation and configuration of open-source Network simulator software
7	Firewall Implementation (IPTABLES)
8	Implementation of SDN
9	Implementation of VPN
10	Cryptography using open-source tools/Crypt tools and open SSL

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	TCP/IP protocol suit	Fourth	Behrouz A. Forouzan (Author)	McGraw Hill Education	2009
2	Introducing Network Design Concepts	-	CCNA Discovery Learning Guide	-	-
3	Computer Networking: A Top-Down Approach	Fifth	J. F. Kurose and K. W. Ross	Prentice Hall	2009
4	Data Communication and Networking	Fourth	B. A. Forouzan	McGraw Hill	2017
5	Information Security: Principles and Practice	First	Deven Shah	Wiley	2007

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud	--	William Stallings	Addison-Wesley ISBN: 9780134175393	2015
2	Computer Networks	Fifth	A. Tanenbaum	Pearson Education	2013
3	Data and Computer Communications	Tenth	William Stallings	Pearson Education	2013

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-1	Mobile and Wireless Communication	2	-	2	2	6	2	-	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC311		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC307: Computer Communication Network
Course Objective: The objective of the course is to provide a fundamental understanding of Mobile and Wireless Communication.	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC311.1	Demonstrate the ability to discuss wireless communication concepts, system capacity and service provided.
EC311.2	Evaluate various path loss and fading effects.
EC311.3	Analyze losses, multipath effects, architecture, and protocols of 3G,4G and 5G systems.
EC311.4	Compare various operational aspects of Wireless Personal Area Networks.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC311.1	2		2									
EC311.2			2	2	2				2	2		
EC311.3	3				2				2	2		2
EC311.4	2	2										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC311.1		2				
EC311.2		2	2			
EC311.3		2	2			
EC311.4		2				

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply √	Analyze√	Evaluate	Create

Theory Component

Module	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Introduction to mobile communication**	1	5
	1.1	Frequency Division Multiple access, Time Division Multiple access, Spread Spectrum Multiple access, Space Division Multiple access, and OFDM.		
	1.2	Frequency reuse, channel assignment strategies, handoff strategies, interference and system capacity, trunking and grade of service, improving the capacity of cellular systems and related design problems		
2	**Title**	**Mobile Radio Propagation**	2,3	10
	2.1	Introduction to radio wave propagation, reflection, diffraction, scattering. Indoor and Outdoor propagation Models. Practical Link Budget Design using path loss models.		
	2.2	Small-Scale Multipath propagation, small scale multipath measurements, types of small-scale fading, fading effects due to Doppler spread. Statistical models for multipath fading channels-Clarks model,2-day Rayleigh fading model, Saleh and Valenzuela indoor model.		
3	**Title**	**3G UMTS Network, 4G LTE and 5G Technologies**	4	8
	3.1	UMTS network architecture, Protocol Structure, Channel Structure, Frame slots and symbols, modulation, coding, multiple antenna techniques, WCDMA, Modulation, Handoff and Power Control.		
	3.2	4G LTE network Architecture, LTE Radio Access, Radio-Interface Architecture, Physical Transmission Resources, Downlink and Uplink Physical-Layer Processing, Scheduling and Rate Adaptation.5G Concepts and Architectures, Network Slicing Architecture, mm Wave communication, multiple Cell Types.		
4	**Title**	**Personal Area Network Technologies**	3	5

	4.1	**Bluetooth:** concepts of Piconet, scatternet etc., protocol stack, link types, security, network connection establishments, usage models, etc.		
	4.2	**Wi-Fi and ZigBee:** components, architecture, network topologies, protocol stack etc.		
5	**Self-Study**	Rayleigh fading model, Saleh, and Valenzuela indoor model**.** UWB and RFID: technical requirements, components and characteristics, applications.	2,3	4*
			Total (* Not Included)	28

Laboratory Components:

Sr. No	Title of the experiment
1	Study of GSM modem: i] Install and configure minicom, wvdial & AT Commandsii] Python scripting.
2	Channel Allocation Techniques
3	Modulation Techniques using GNU Radio.
4	Spread Spectrum Modulation, OFDM Modulation.
5	Wireless Path Loss Computations: I] Free-space Propagation Path Loss Model ii] Indoor Propagation Model - Okumura Model etc.
6	Wireless Path Loss Computations: iii] Outdoor Propagation Model - Hata Model etc
7	Open-Source LTE/EPC Network Simulation using NS-3, Omnet++
8	Open-Source Personal Area Network simulation using NS-3, Omnet++
9	Millimeter Wave (5G) Network, Wi-Fi Network simulation usingNS-3, Omnet++
10	Virtual Lab.

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Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Wireless Communications	Third	Theodore S. Rappaport	Prentice Hall of India, PTRpublication	-
2	Wireless Communications	Second	Andreas Molisch	Wiley	-
3	Wireless Network Evolution 2G-3G	Third	Vijay Garg	Pearson Education	
4	4 G Roadmap and Emerging Communication Technologies	Second	Young Kyun Kim and Ramjee Prasad	Artech house	

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Wireless Communication	Second	Singhal	TMH	
2	Mobile Communication	Second	C.Y Lee	Wiley	

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Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-2	Microwave Communication	2	0	2	6	11	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC312		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide a fundamental understanding of Microwave Communication	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC312.1	Apply EM Wave theory to understand nature of Microwave Signal and their corresponding guiding structures.
EC312.2	Identify Passive Waveguide Components, Sources and Detectors
EC312.3	Analyze Passive Waveguide Components, Sources and Detectors
EC312.4	Compute amplifier and filter design parameters on the basis of application/requirement.
EC312.5	Justify choice of amplifier and filter design parameter.
EC312.6	Design Microwave System components.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC312.1	3	3	3	1	3					3		
EC312.2	2	2	2	2	3					3		
EC312.3	2	2	2	2	3					3		
EC312.4	2	2	2	2	3					3		
EC312.5	2	2	2	2	3					3		
EC312.6	3	3	3		3					3		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC312.1		2			-	
EC312.2		2			-	
EC312.3		2			2	
EC312.4		2			2	
EC312.5		2			2	
EC312.6		1				

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Microwave Engineering**	1	10
	1.1	Lumped and Distributed Elements, Frequency Bands, Characteristics, Application, Advantages, and disadvantages		
	1.2	Rectangular and circular waveguides: TE, TM modes, dominant mode		
	1.3	Microwave Components: Resonators, re-entrant cavities, scattering parameters, tees, hybrid ring, directional couplers, phase shifters, terminations, attenuators, ferrite devices such as isolators, gyrators, and circulators.		
2		**Microwave Tubes and semiconductor devices**	1	10
	2.1	Two Cavity Klystron and Reflex Klystron, Helix Travelling Wave Tube, Cross Field Amplifier, Cylindrical Magnetron.		
	2.2	PIN Diode, Varactor Diode, Schottky Diode, Gunn Diode, Tunnel Diode, IMPATT Diodes.		
3		**Microwave Amplifiers and Filters**	1	08
	3.1	Two port power gain and stability		
	3.2	Microwave Low pass Filter design		
4(Self Study)		**Microwave Frequency Applications:** Radars, Biomedical Devices, Drying materials, Microwave Tomography, Satellite Communication		06
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments using both hardware and software are expected)

Sr. No	Title of the Experiment
1	Model and simulate rectangular waveguide in CAD to study EM wave propagation within it.
2	Model and simulate circular waveguide in CAD to study EM wave propagation within it.
3	Design of Waveguide H-plane TEE using CAD
4	Design of Directional Coupler Using CAD
5	Design of Low pass Filter using CAD
6	Implementation of a technical paper using CAD
7	Microwave bench setup (CO1) A) Introduction to the lab B) Identification of waveguide and its components. How to determine the parameters for each component by looking at the data sheet. C) Klystron setup and characterization plotting Vr vs Vo D) Frequency and

	wavelength measurement of the signal generated by klystron
8	Determination of parameters of passive components using Bench and VNA. Analysis of comparative study to be submitted.
9	Determine the frequency and wavelength in a rectangular waveguide using direct and indirect measurement.
10	Design of Planar Hybrid Ring using CAD

Textbooks:

S. N.	**Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Microwave Engineering	David M Pozar	Fourth	John Wiley & Sons	**2012**
2	Microwave Devices and Circuits	Samuel Y Liao	Third	Pearson Education	

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-I	Speech and Audio Processing	2	0	2	8	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC321		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC303: Digital Signal Processing
Course Objective: To familiarize the basic & advance mechanisms of speech and audio processing	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC321.1	Apply concepts of speech coding.
EC321.2	Analyze Audio Perception& psycho-acoustic model.
EC321.3	Demonstrate parametric representation, time domain & frequency domain representation of speech.
EC321.4	Analysis of predictive methods of speech.
EC321.5	Develop systems for various applications of speech& audio processing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC321.1	2											
EC321.2		2										
EC321.3			2									
EC321.4			2		2							
EC321.5					2							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC321.1	2			2		
EC321.2	2			2		
EC321.3		2			2	
EC321.4		2			2	
EC321.5		2			2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze√	Evaluate√	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Mechanics of speech**		
	1.1	Speech production: Mechanism of speech production, Acoustic phonetics – Digital models for speech signals -Sampling speech signals, basics of quantization, delta modulation, and Differential PCM	1,2	8
	1.2	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model.	1,2	
2	Title	**Time domain methods for speech processing**		8
	2.1	Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude, zero crossing Rate – Silence Discrimination using ZCR and energy	1,2	
	2.2	Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.	4	
3	Title	**Frequency domain method for speech processing**	1,2	8
	3.1	Short Time Fourier analysis: Fourier transform and linear filtering interpretations.	4	
	3.2	Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder.	2,3	
	3.3	Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders, Speech coding, speech enhancement.	3,5	
4	Title	**Linear predictive analysis, synthesis of speech**	3,5	4
	4.1	Basic Principles of linear predictive analysis – Auto correlation method – Covariance method.		
	4.2	Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm.		
	4.3	Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP, Speech synthesis: basics of articulatory, source-filter, and concatenative synthesis – VOIP.		
5	Self Study	Audio compression methods, Audio quality analysis, Spatial Audio Perception and rendering, Speaker identification and verification		
			Total	**28**

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Laboratory Component

Sr No.	Experiment Title
1	Speech production
2	Analysis of speech signal
3	Short-time spectrum analysis of speech
4	Spectrographic analysis of speech
5	Linear prediction analysis of speech
6	Formant synthesis
7	Cepstral analysis of speech
8	Analysis by synthesis of speech
9	Manual speech signal-to-symbol transformation
10	Speaker Analysis /speaker recognition

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Speech Communications: Human & Machine	Second	Douglas O'Shaughnessy	IEEE Press, Hardcover 2/e, ISBN: 0780334493.	1999
2	Discrete-Time Speech Signal Processing	First	Thomas F, Quatieri,	Prentice Hall /Pearson Education	2004

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Speech Processing and Synthesis Toolboxes	First	Donald G. Childers	John Wiley & Sons, September ISBN:0471349593	1999
2	Fundamentals of Speech Recognition	First	L.R. Rabiner and B. H. Juang	Prentice Hall	2009
3	Speech and Audio Signal Processing	Second	Ben Gold and Nelson Morgan	John Wiley and Sons Inc., Singapore	2011
4	Discrete Time Processing of Speech Signals	First	J.R. Deller, J.H.L. Hansen and J. G. Proakis	John Wiley, IEEE Press	1999
5	Digital Processing of Speech Signals	First	L. R. Rabiner and R. W. Schaffer .	Prentice Hall	1979

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-2	DSP Processors	2	0	2	4	4	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC322		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC303: Digital Signal Processing
Course Objective: To develop implementation of DSP algorithms using DSP Processor	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC322.1	Evaluate different types of errors in DSP implementation.
EC322.2	Describe architectures of TMS320XX devices.
EC322.3	Explore various interfacing devices to DSP Processors.
EC322.4	Demonstrate Fast DSP algorithms using DSP processor
EC322.5	Develop DSP application using DSP hardware.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC322.1	2											
EC322.2		2	1									
EC322.3		2	1									
EC322.4	2				1							
EC322.5			2					1	1	1		1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC322.1		2		2		
EC322.2		2		2		
EC322.3		2		2		
EC322.4		2		2		
EC322.5		2		2		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Computational Accuracy in DSP Implementations**		04
	1.1	Number formats for signals and coefficients in DSP systems. Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.	1,2	
	1.2	Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors.	1,2	
2	Title	**Programmable DSP Hardware**		08
	2.1	Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT).	1,2	
	2.2	IEEE standard for Fixed- and Floating-Point Computations, Special Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.	1,2	
3	Title	**Structural and Architectural Considerations**		06
	3.1	Parallelism in DSP processing, Texas Instruments TMS320 Digital Signal Processor Families, Fixed Point &floating-Point TI DSP Processors.	1,2	
	3.2	Data Addressing modes, Memory space of Processors, Program Control, instructions, and programming of TMS320XX Processors.	1,2	
	3.3	On-Chip Peripherals, Interrupts of TMS320XX processors, Pipeline operation of TMS320XX Processors.	1,2	
4	Title	**VLIW Architecture**		06
	4.1	Current DSP Architectures, GPUs as an alternative to DSP Processors.	1,2	
	4.2	Code Composer Studio, Mixed C and Assembly Language programming, on-chip peripherals, Simple applications developments as an embedded environment.	1,2	
	4.3	Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).	1,2	
5	Title	**Hardware implementation of DSP Algorithms**		04
	5.1	The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters	1,2	
	5.2	An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation	1,2	
6	Self-Study	A CODEC interface circuit, A CODEC-DSP interface example.		
			Total	**28**

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Laboratory Component

Sr. No	Title of the Experiment
1	Harmonic Generation
2	FIR Filtering
3	IIR Filtering
4	Fast Fourier Transform Algorithm
5	Linear Filtering Algorithm
6	Sensor Interface
7	ADC-DAC Interface
8	Real Time Audio Signal Processing
9	Real time Biomedical Signal Processing
10	Real Time Power Signal Processing

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processors, Architecture, Programming and Applications.	First	B. Venkata Ramani and M. Bhaskar	Tata McGraw Hill (TMH) Publication 2004	2004
2	DSP Implementation using DSP microprocessor with Examples from TMS32C54XX	First	Avtar Singh, S. Srinivasan	Thomson Publication	2004

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	DSP Processor Fundamentals, Architectures & Features	First	Phil Lapsley, Jeff Bier, AmitShoham, Edward A. Lee	Wiley Publication	1997
2	Digital Signal Processors Architectures, Implementation and Application	First	Sen M. Kuo & WoonSergGan,	Pearson	2009
3	Architectures for Digital Signal Processing	First	Peter Pirsch,	Wiley Publication	1998
4	Digital Signal Processing	Second	S. Salivahanan A. Vallavaraj G. Gnanapriya	Tata McGraw Hill Publication	2001

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Digital CMOS VLSI Design	3	--	--	5	8	3	--	--	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC331		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	ET101: Basic Electrical Engineering EC101: Digital Systems and Microprocessors ET202: Electronic Devices ET205: Analog Circuits
Course Objective: Today's growth in electronic sector is due to improvements in semiconductor chip design. VLSI course is the foundation course introduced to teach fundamentals of MOSFET based logic circuit design. The primary objective of this course is to impart basic knowledge required to study advanced courses in VLSI domain.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
EC331.1	Discuss scaling theory for MOSFET
EC331.2	Design MOSFET based inverter circuits with given constraints
EC331.3	Analyze MOSFET based combinational and sequential logic circuits
EC331.4	Realize MOSFET based logic circuits with different design styles
EC331.5	Discuss principle of working of semiconductor memories

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

EC331	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC331.1	3											
EC331.2		3										
EC331.3			3									
EC331.4			3									
EC331.5			3									

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

EC331	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC331.1	1	2	2			
EC331.2	2	1	2		2	2
EC331.3	1	1	1		2	
EC331.4	2	2	2		2	
EC331.5	1	2	1		2	

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	Understand	Apply ·	Analyze · √	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	**Review of MOSFET Physics**		08
	1.1	Threshold Voltage Equation, MOSFET Structure and Operation, Current-Voltage Characteristics and MOSFET Capacitances	1	
	1.2	MOSFET Scaling, Types of scaling and small geometry effects	1	
2	Title	**MOSFET Inverters**		08
	2.1	Static Characteristics of resistive load and CMOS Inverter, comparison of all types of MOS inverters	1	
	2.2	Dynamic Characteristics of inverters, design of CMOS inverters with constraints	1	
3	Title	**Combinational MOS Logic Circuits**	1,2	08
	3.1	MOS Logic Circuits with Depletion NMOS Loads and CMOS Logic Circuits		
	3.2	Complex Logic Circuits and Concept of equivalent CMOS inverter		
4	Title	**Dynamic Logic Circuits**	1	08
	4.1	Static CMOS, pass transistor logic, transmission gate		
	4.2	Pseudo NMOS, Domino, NORA, Zipper, C^2MOS		
5	Title	**Sequential MOS Logic Circuits**	1,2	06
	5.1	Behavior of Bi-stable Elements		
	5.2	**Circuit Realization:** SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, decoder		
6	Title	**Semiconductor Memories**	2,3	06
	6.1	ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits),		
	6.2	DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits),		
	6.3	Flash (mechanism, NOR flash, NAND flash)		
	6.4	**Peripheral Circuits:** Sense amplifier, decoder		
			Total	42

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Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	CMOS Digital Integrated Circuits Analysis and Design	Third Edition	Sung-Mo Kang, Yusuf Leblebici	Tata McGraw Hill	
2	Digital Integrated Circuits: A Design Perspective	Second Edition	Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Pearson Education	
3	Introduction to VLSI Circuits and Systems	Student Edition	John P. Uyemura	Wiley	2013

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Embedded Systems	3	--	--	5	8	3	--	--	3
		Examination Scheme								
EC332		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	EC101: Digital Systems and Microprocessors ET201: Computer Architecture and Organization ET206: Microcontrollers
Course Objective: To empower the students in system design skills using modeling practices and learn key concepts in reliability of embedded systems with respect to Industrial standards.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
EC332.1	Discuss design metrics of embedded system to design real time applications to match recent trends in technology.
EC332.2	Analyze the reliability of embedded system with respect to fault detection and fault tolerance
EC332.3	Apply the industry standards for assessment of embedded product
EC332.4	Analyze the given embedded application with respect to security
EC332.5	Choose suitable criteria for selection of embedded application.
EC332.6	Demonstrate hardware and software skills based on embedded case studies.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC332.1	2	2	2									
EC332.2	2	2	2									
EC332.3	2	2	2									
EC332.4	2	2	2									
EC332.5	2	2	2									
EC332.6	2	2	2	2	2							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC332.1		1				
EC332.2	1		1			
EC332.3	1		1			

EC332.4	1	1	1			
EC332.5		1	1			
EC332.6	1		1	2		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	**Understand ·**	**Apply ·**	**Analyze · √**	**Evaluate**	**Create**

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	**Title**	**Fundamentals of Embedded System**		**12**
	1.1	Introduction to Embedded Systems, Characteristics of Embedded System, Design Process, Design Metrics, and optimization of various parameters of embedded system. Design trade-offs due to process compatibility, thermal considerations, etc. Real time System's requirements, real time issues, interrupt latency	1,2	
	1.2	Embedded Product development lifecycle. Program Modeling concepts with design examples: DFG, FSM, Petri-net, UML, Use case, Object and Class Structuring	1,2	
	1.3	Technological aspects of embedded systems: Embedded microcontroller cores, embedded memories, interfacing between analog and digital blocks, signal conditioning, digital signal processing, sub system interfacing, interfacing with external systems and user interfacing. Introduction to real time programming languages and operating systems for embedded systems.	1,5	
2	**Title**	**Reliable Embedded System**		**08**
	2.1	Reliable Embedded System: Single-program, real-time embedded systems, TT vs. ET architectures, Modeling system timing characteristics, basic tick lists, determining the required tick interval, short tasks, importance of task offsets, task sequence initialization, task jitter, response times, importance of WCET/BCET information, challenges with WCET/BCET measurements, TTC scheduler, Fault-tolerance Techniques	3	
3	**Title**	**Industry Standards**		**06**
	3.1	Introduction to IEC 61508 standard: Organizing and managing the life cycle, Requirements involving the specification, Requirements	6,7	

		for design and development, Integration and test, Operations and maintenance, Validation, Modifications, acquired sub-systems, Organizing, and managing the software engineering		
	3.2	Introduction to IEC 60601 standard: Protection of radio services, Protection of the Public Mains network, Immunity, Electrostatic Discharge, Radiated RF electromagnetic fields, Electrical fast transients and bursts.	8	
	3.3	Introduction to IEC 26262: Introduction of ISO/DIS 26262 (ISO 26262), Parts of ISO 26262, ASIL Levels, Product Development System Level, Product Development Software Level, Fitting software tools into ISO 26262 process	9	
4	**Title**	**Security in Network Embedded System**		**08**
	4.1	Networked Embedded System: Network Fundamentals, Layers and Protocols. Network Architectures, Network Components-Bridges, Routers, Switches, Distributed Embedded Architectures, Elements of Protocol Design, High Level Protocol Design Languages, Network Based Design, Internet-Enabled Systems: Protocols for industrial and control applications, Internetworking Protocols. Wireless Applications: Blue tooth	10	
	4.2	Security in Embedded Devices and Systems: Introduction to secure embedded systems, The Key, Using Keys, Various protocols, attacks on embedded systems and counter measures.	4	
5	**Title**	**Case Studies ***		**08**
	5.1	**Embedded Control Applications:** Introduction, Open-loop and Closed Loop Control Systems Examples: Speed Control. PID Controllers: Software Coding of a PID Controller, PID tuning. Fuzzy Logic Controller Application Examples: Washing Machine, Auto-focusing digital camera and Air-conditioner	1,2	
	5.2	**Automotive Embedded Systems**: Automotive Architectures, embedded communication, embedded software and development processes, Verification, Testing and Timing Analysis	1,2	
	5.3	Embedded systems in healthcare domain.	1,2	
Total				**42**

*** Students are supposed to do some experiments/mini-projects as per instructions of teacher and requires individual efforts of students**

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Embedded System: Architecture, Programming and Design	2nd edition	Rajkamal	Tata McGraw-Hill	2011
2	Introduction to Embedded Systems	2nd edition	Shibu K. V	Tata McGraw-Hill	2017
3	The Engineering of Reliable systems: LPC1769	-	Pont M. J	SafeTTy Systems	2014
4	Security in Embedded Devices	2010th edition	Gebotys, Catherine H.	Springer	2010
5	Embedded Microcomputer Systems: Real time Interfacing	3rd edition	Jonathan W. Valvano	Cengage Learning	2012
6	Functional Safety, A Straightforward Guide to applying IEC 61508 and Related Standards	2nd edition	David Smith	Elsevier	2004
7	IEC 61508: IEC standard for the functional safety for electrical, electronics and programmable electronics equipment	-	-	https://www.iec.ch/safety	-
8	IEC 60601: IEC standard on Medical Electric Equipment	-	-	https://www.iec.ch/safety	-
9	IEC 26262: IEC standard on Road vehicles	-	-	https://www.iec.ch/safety	
10	Embedded Systems Handbook: Networked Embedded Systems	2nd edition	Richard Zurawski	CRC Press	2009

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Power Electronic Converters (@)	3	0	0	5	8	3	0	0	3
		Examination Scheme								
		Component			ISE		MSE		ESE	Total
EC341A		Theory			75		75		150	300

@--> Not to be repeated if already studied as a Program Core i.e. Power Electronics

Pre-requisite Course Codes, if any.	Basic Electrical Engineering
Course Objective: To impart knowledge on the basic topology, operation and analysis using performance parameters of power electronic converters.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC341A.1	Understand the operation of power semiconductor switches.
EC341A.2	Analyze various single and three phase AC-DC power converter circuits
EC341A.3	Illustrate the operating principle and construct a various type of DC-DC converters.
EC341A.4	Analyze various single and three phase DC-AC power converter circuits
EC341A.5	Understand the operation of AC-AC voltage converters by means of circuit topology and waveforms.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
EC341A.1	2.5											
EC341A.2	2	3										
EC341A.3		2										
EC341A.4		2.5	2.5									
EC341A.5	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC341A.1	2	1					
EC341A.2	2				2		
EC341A.3	2				2		
EC341A.4	2				2		
EC341A.5							

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Power Semiconductor Devices**		
	1.1	Principle of operation, constructional features, characteristics of: SCR, GTO, MOSFET and IGBT, Si-Carbide-MOSFET and IGBT, Ga-Ni Power devices, Common type of Power Modules	T1, T3	8
	1.2	Basic Gate Drive circuits for SCR, MOSFET and IGBT		
2	Title	**AC to DC Converters**		
	2.1	Operation and analysis of single-phase controlled rectifiers with R, and RL load, freewheeling effect. Operation and analysis of three-phase controlled rectifiers with resistive load, effect of source inductance.	T1, T2, R4	10
	2.2	Single Phase and Three-Phase PWM Rectifier, Vienna Rectifier. Power factor improvements	T1, R4	
3	Title	**DC to DC Converters**		
	3.1	Switch Mode Power Converters, non-isolated and isolated converters, Buck, Boost and Buck-Boost converters, flyback and forward converters, Hardware design of SMPS converters and their Magnetics	T1, R4	8
	3.2	Closed loop control of Switched Mode DC-DC Converters with Constant Voltage and Constant Current mode of Operation	R5	
4	Title	**DC to AC Converters**		
	4.1	Principle of operation of Inverters, Inverter Classification.	T1,	
	4.2	Voltage source inverters: -Principle of operation and analysis of: Single phase Half bridge, full bridge, and three-phase bridge inverters, six step operation (R-Load), PWM control of Voltage source converters. Introduction to Space Vector Modulation	T2, R4	10
5	Title	**AC–AC converters**		
	5.1	Principle of on-off and phase control – single-phase half and full wave AC voltage controller, three-phase AC voltage controller. Single Phase Bidirectional AC switches using MOSFETs, IGBTs, Single-phase Bidirectional AC-AC converters	T2 R6	6
6	Self Study	Exercise on minimum of 4 to 6 Simulations		6*
			Total (*not included)	42

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In-Semester Evaluation (Indicative): To be completed minimum of 4 to 6 Simulations

Sr. No	Title
1	Simulation Exercise on Single phase Line Commutated Semi-converter and Fully controlled Converter
2	Simulation Exercise on Single phase PWM Vienna Rectifier
3	Simulation Exercise on Single- phase bridge inverter with R Load and controllable Switches
4	Simulation Exercise on PWM three phase bridge Voltage Source inverter with L-C filter
5	Simulation Exercise on Buck-Converter and Boost Converter in CCM
6	Simulation Exercise on Fly-back-Converter
7	Simulation Exercise on Single-phase AC Voltage Controller using Thyristors
8	Simulation Exercise on PWM Vienna Rectifier
9	Simulation Exercise on Single-phase PWM AC-AC converters with Bidirectional switches

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Power Electronics: converters, Application and design	Third	Ned Mohan, Undeland and Robbin	John Wiley and sons	2003
2	Power Electronics Circuits, Devices and Applications	Fourth	Rashid M.H.	Pearson Education	2004
3	Power Electronics	Second	MD Singh and K.B Khanchandani	Tata McGraw Hill	2006

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Power Electronics and AC Drives	First	Bimal K Bose	Pearson Education Asia	2002
2	Modern Power Electronics	Second	P.C Sen	S. Chand	2005
3	Power Electronics	Eleventh	P. S. Bimbra	Khanna Publishers	2003
4	Power Electronics	First	S. K. Mandal	McGraw Hill Education (India)	2014
5	Switch-mode power converters	First	Keng C. Wu.	Elsevier Inc.	2006,
6	Advanced Power Electronics Converters	First	EUZELI CIPRIANO DOS SANTOS JR., EDISON ROBERTO CABRAL DA SILVA	John Wiley & Sons	2015

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-1	IC and MEMS Technology	3	0	0	5	8	3	0	0	3
		Examination Scheme								
EC341B		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	ET202 Electronic Devices ET205 Analog circuits
Course Objectives: To develop a system for real life application by applying the concepts of control system theory and allied techniques for system performance evaluation.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
CO1	Discuss integrated circuit fabrication processes
CO2	Illustrate the sequence of process of semiconductor device fabrication
CO3	Discuss fundamental principles of MEMS devices including physical operation and mathematical modeling.
CO4	Apply various fabrication processes and materials for MEMS device fabrication and its Characteristics.
CO6	Develop different concepts of micro system sensors and actuators for real world applications.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	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
CO1	3							3	3	3					
CO2			3					3	3	3					
CO3	3							3	3	3					
CO4				3				3	3	3					
CO6			3					3	3	3					
CO	**3**		**3**	**3**				**3**	**3**	**3**					

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CO1	**1**	**1**	**2**			--	
CO2	**1**	**1**	**2**			--	
CO3	**1**	**1**	**2**			**2**	
CO4	**1**	**1**	**2**			--	
CO6	**1**	**1**	**2**			--	
CO1	**1**	**1**	**2**			--	

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Environment and Crystal Growth for VLSI Technology**		08
	1.1	**Environment**: Semiconductor technology trend, clean rooms, Wafer cleaning.	1,2	
	1.2	**Semiconductor Substrate:** Phase diagram and solid solubility, Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation and specifications.	1,2	
2		**Fabrication Processes Part 1**		08
	2.1	**Deposition:** Evaporation, Sputtering and Chemical Vapor Deposition.	1,2	
	2.2	**Epitaxy:** Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers	1,2,3,4	
	2.3	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics.	1,2	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers.	1,2,3,4	
	2.5	**Ion Implantation**: Penetration range, ion implantation systems, process considerations, implantation damage and annealing.	1,2	
3		**Fabrication Processes Part 2**		08
	3.1	**Etching:** Wet chemical etching, dry physical etching, dry chemical	1,2	
	3.2	**Lithography:** Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography.	1,2	
	3.3	Device Isolation, Contacts and Metallization: Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging: Integrated circuit packages, Electronics package reliability	1,2	
	3.4	**CMOS Process Flow:** N well, P-well and Twin tub	1,2	
	3.5	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact.	1,2	
4		**Introduction to MEMS, MEMS Materials and Properties**		10
	4.1	Introduction to MEMS Technology, Difference between ICT & MEMS Technology, Difference between ICs and MEMS Devices and Real-world Sensors/Actuators examples with brief description.	3,4	
	4.2	Architecture, working and basic quantitative behaviour of MEMS devices like Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head.	3,4	

	4.2	Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt); Important properties: young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.	3,4	
	4.3	Bulk, Surface & LIGA Micromachining, Die, Wire & Wafer Bonding, Dicing, Packaging.	3,4	
5		**MEMS Devices Fabrication and Characterization**		**06**
	5.1	Understanding steps involved and materials used in Fabricating MEMS device like Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head and Selection of Fab processes and materials based on fabrication of a given MEMS device and its intended application.	3,4	
	5.2	**MEMS Devices Characterization:** MEMS Device dimensions, Piezo resistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior.	3,4	**02**
Self Study		Packaging of ICs and MEMS devices, IC and MEMS Reliability	1,2,3,4	**05***
			(*not included) Total	**42**

Textbooks:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Silicon VLSI Technology	Fifth	James D. Plummer, Michael D. Deal and Peter B. Griffin	Pearson, Indian Edition	2020
2	Micro Electromechanical System Design	First	J. Allen	CRC Press	2005
3	Microsystem Design	First	S. Senturia	Springer	2005

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	The Science and Engineering of Microelectronic Fabrication	Second	Stephen A. Campbell	Oxford University Press	2012
2	VLSI Fabrication Principles	First	Sorab K. Gandhi	Wiley, Student Edition	2008
3	An Introduction to Microelectromechanical Systems Engineering	Second	N. Maluf, K Williams	Artech House Inc	2002
4	Practical MEMS	First	Ville Kaajakari	Small Gear Publishing	2009

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ISE Evaluation: Simulation based work as per the indicative details given in Table 1 using open source and proprietary tools to simulate fabrication processes, MEMS devices and compare the results of simulation with analytical results. (At least 4 to 6 Simulations)

Table 1:

Sr. No.	Simulation Work
1	Use nano hub platform to simulate and analyze the Oxidation process for various process parameters and wafer specifications. Use nano hub platform to simulate and analyze the diffusion process for various given conditions.
2	To use Industry graded VLSI CAD tools to draw layout and analyze CMOS Inverter circuit. To use Industry graded VLSI CAD tools to draw layout and analyze MOS based circuit.
3	To analyze MEMS cantilever in MATLAB.
4	To model and analyze MEMS cantilever in COMSOL Multiphysics. To model and analyze the Hot Arm actuator in COMSOL Multiphysics. To model and analyze Piezoresistive Pressure Sensor in MEMS Design and Simulation FEM Tool (CoventorWare).
5	To analyze MEMS Piezoelectric Harvester model in Sugar tool. To analyze MEMS cantilever in Sugar Tool.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE-2)	Embedded System Design for Power Converter Applications	3	0	0	5	8	3	0	0	3
		Examination Scheme								
		Component			ISE		MSE		ESE	Total
EC342		Theory			75		75		150	300

Course content

Digital Signal Controller (DSC: A micro-controller with a DSP engine): Architecture and real-time programming in Assembly and Embedded C. Introduction to Fixed Point Arithmetic. Understanding the constraints of program memory and execution time. Programming peripherals including GPIO, TIMERS etc. On Chip FLASH and EEPROM programming.

Field Programmable Gate Array (FPGA): Architecture and programming of digital circuits including Finite State Machines (FSM) in Verilog HDL. Understanding the CAD tool and various timing issues.

Communication-Chip level: AXI, Board level: SPI, I2C, System level: RS 232, CAN, MODBUS RTU on RS 485. Developing a GUI for supervisory control and monitoring. Introduction to different semiconductor memories: RAM, ROM, NVRAM etc. and their applications.

Analog sensing: Anti-aliasing filter design, scaling, online calibration and biasing. Continuous time feedback controller design and its discrete time implementation, D/A and A/D converters, effects of sampling, modeling the Pulse Width Modulator (PWM) etc.

Co-design: How to optimally implement an embedded task using a programmable processor (DSC) and a re-configurable hardware (FPGA). Embedded design of a typical Power Conversion System including: process control, protection, monitoring, real-time feedback control etc.

Concept of Hardware-in-the loop simulation in Power converters, Case-study: Design of Embedded system controller for (a) Induction Heating System (b) Three Phase Active Rectifier for PF Correction

Prerequisites

Undergraduate level analog electronics, digital electronics and classical feedback control theory. Familiarity with micro-processor, digital signal processing and previous experience in programming will be helpful but not a necessity.

References

(1) Fundamentals of Digital logic with Verilog Design, S Brown and Z Vranesic, McGraw Hill Education; 2nd edition (2017).

(2) PIC Micro-controllers and Embedded Systems, Using assembly and C for PIC 18 Mazidi, Mckinlay and Causey, Pearson Education India; 1st edition (2008)

(3) Feedback Control of Dynamic Systems, GF Franklin, JD Powell and Naeini, Pearson (2008)

(4) Microelectronic Circuits: Theory and Applications, AS Sedra and K Smith, Oxford University Press (2017)

(5) Digital Signal Processing, JG Proakis and DK Manolakis, Pearson Education India; 4th edition (2007)

(6) Digital Control of High Frequency Switched Mode Power Converters, (IEEE Press Series on Power Engineering) Lucca Corradini, Dragan Maksimovi, Paolo Mattavelli, Regan Zane, Wiley-Blackwell (2015)

(7)A Practical Introduction to Hardware/Software Co-design, Patrick R. Schaumont Springer; 2nd edition (2014).

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Networking Fundamentals (@)	2	-	2	3	7	2	-	1	3
		Examination Scheme								
EC351		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

@--> Not to be repeated if already studied as a Programme Core i.e. Computer Communication Networks

Pre-requisite Course Codes, if any.	ET301: Analog and Digital Communication
Course Objective:	
Course Outcomes (CO): At the end of the successful completion of the course students will be able to	
E3451.1	Identify network topologies, physical devices and standards
E3451.2	Recognize the significance of multiple layers of the OSI model in networking environment.
E3451.3	Solve network issues by using IP addressing concepts.
E3451.4	Examine the current challenges in computer security and identify possible solutions to resolve the same.

CO-PO Correlation Matrix: (1-Weak, 2-Medium 3-Strong)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
E3451.1	3	3										
E3451.2			3	2	3							2
E3451.3			3		3	2						
E3451.4	2	2							3	3		3

CO-PEO/PSO Correlation Matrix: (1-Weak, 2-Medium 3-Strong)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
E3451.1	2						
E3451.2						2	
E3451.3						2	
E3451.4	2					2	

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BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	Understand	Apply · √	Analyze ·	Evaluate ·	Create

Theory Component

Module No.	Unit No.	Topics	CO	Ref.	Hrs
1	Title	**Introduction**	CO1	1,2	06
	1.1	Topologies, LAN, MAN, WAN			
	1.2	Introduction to networking devices			
	1.3	Transmission Medias: Wired and Wireless network			
2	Title	**Reference Models**	CO2	1,2	06
	2.1	Defining Networks with the OSI and TCP/IP Model			
3	Title	**IP addressing**	CO3	1,2	06
	3.1	Working with IPv4: IP addressing schemes, Subnet Masks, Subnetting, Introduction to IPv6.			
4	Title	**Introduction to Network Security**	CO4	3	10
	4.1	Introduction to Core Security Principles: Confidentiality, Integrity, Availability, Authentication.			
	4.2	Cryptography Threats: Malware Attacks, Social Engineering			
	4.3	Attacks, Networking-based and Server based Attacks			
5	Self Study	**Fairness algorithms, Congestion Control mechanisms.**			*03
				Total (*Not included)	28

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Identify and observe the behavior of networking command line tools in Ubuntu/Windows OS environment.
2	To build and test straight through UTP ethernet network cables.
3	Write a program in C/C++/Python/Java/Scilab to identify the IP address, Subnet mask, DNS server address and Hardware address of the client device.
4	Write a program in C/C++/Python/Java/Scilab to determine the administrator's requirement to define the number of subnets, host/subnet, customized subnet masks and valid subnet ranges for a class C IP addressing scheme.

5	Examine Data Breaches and Scan for Malware Using the Microsoft Safety Scanner
6	Handson experience on how to Write-Protect and Disable a USB Flash Drive
7	Protocol Visualization with open-source tools
8	Network Reconnaissance using open-source tools
9	Web Reconnaissance Using a Web Browser/open-source tools
10	Cryptography using open-source tools/Crypt tools and open SSL
11	Install and configure application-based server

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Data Communication and Networking	4th	A.A. Forouzan	McGraw Hill	2017
2	Data and Computer Communications	10th	William Stallings	Pearson Education	2013
3	Information Security: Principles and Practice	1st	Deven Shah	Wiley	2007

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Computer Networking: A Top-Down Approach	5th	J. F. Kurose and K. W. Ross	Pearson Education	2009
2	Computer Networks	5th	A.Tanenbaum	Pearson Education	2013
3	Computer Networks: Protocols, Standards and Interface	2nd	Uyless Black	Prentice Hall	1993

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Fundamentals of Antenna	3	-	-	6	09	3	-	-	3
EC352A		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide a fundamental understanding of Antennas	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC352A.1	Calculate the fundamental parameters of Antenna.
EC352A.2	Describe fundamental theory of antennas.
EC352A.3	Select antenna based on applications.
EC352A.4	Evaluate antenna based on applications.
EC352A.5	Design Antenna Arrays.
EC352A.6	Design antenna based on given requirements.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC352A.1	2	3						2	2	2		
EC352A.2	2	3						2	2	2		
EC352A.3		2						2	2	2		
EC352A.4		2		2				2	2	2		
EC352A.5		2		2				2	2	2		
EC352A.6	2	1						2	2	2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC352A.1		2				-	
EC352A.2		2				2	
EC352A.3		2				2	
EC352A.4		2				2	
EC352A.5		2				2	
EC352A.6		1				1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1 (CO1)		**Fundamental Concepts:**	1	08
	1.1	Introduction, types of Antennas, Radiation mechanism, Poynting vector, Steradian concept, Power intensity		
	1.2	Antenna Parameter: Radiation pattern, Radiation power density, Radiation Intensity, Gain, Directivity, HPBW, FNBW, Beam efficiency, Bandwidth, Polarization, Input Impedance, Reflection coefficient, Return loss, VSWR, Antenna Efficiency, Effective Aperture, Communication link and Friis transmission equation.		
2 (CO2, CO3)		**Radiation from wires and loops**	1	10
	2.1	Introduction, Infinitesimal dipole: Radiation zones, Total radiated power, Radiation resistance, Directivity, Effective area, Short dipole, Finite-length dipole: Radiated power, Radiation resistance, Directivity, Effective area, Half-wave dipole and its properties, Loop antenna.		
3 (CO3, CO4)		**Aperture Antennas**	1	06
	3.1	Introduction, Field equivalence principle, Love's equivalence principle, Electrical and magnetic conductor equivalence principle, Computation of field quantities of aperture antenna, Relation between wire and aperture antennas, Horn antenna design principle.		
4 (CO5)		**Antenna Arrays**	1	10
	4.1	Introduction, Two-element array, Example problems, Pattern multiplication concept, N-element array, Uniform array, Array factor, Broad-side and end-fire arrays, Phased array, Directivity and pattern characteristic of linear uniform array, non-uniform array, Binomial array, Dolph-Chebyshev array concept, Design principle of Chebyshev array and examples, Planar arrays		
5 (CO6)		**Microstrip Antennas**		
	3.1	Introduction: Rectangular Patch, Circular Patch, Parametric study, Circularly polarized antennas, Axial Ratio, MSA suspended Configuration.	1,4	08
	3.2	MSA Arrays and Feed Networks, Corporate and Series Feeds		
6 (Self Study)		**Advanced Antennas:** Reflector antenna, Dielectric Resonator antenna, Metamaterial based antennas, Wearable antenna, Reconfigurable antennas, Ultra-wideband antennas, Smart Antennas		06
			Total	**42**

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Textbooks:

S. N.	Title	Authors	Edition	Publisher	Year
1	Antenna Theory: Analysis and Design	Constantine A. Balanis	Fourth	Wiley	1982

Reference Books:

S. N.	Title	Authors	Edition	Publisher	Year
1	Antennas & Wave Propagation	J. D. Kraus, R.J. Marhefka, and A.S. Khan	Fourth	McGraw Hill	2011
2	Handbook of Microstrip Antennas	R. James and P.S. Hall	Third	Peter Peregrinus	1989
3	Antennas and Radio Wave Propagation	R. E. Collin	Fourth	McGraw-Hill	1985
4	Broadband Microstrip antennas	Girish Kumar and K.P. Ray	First	Artech House	2003

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-2	Information Theory and Coding	2	0	2	2	6	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC352B		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC301: Analog and digital communication EC307: Computer Communication Networks
Course Objective: To introduce the principles and applications of information theory. To teach study how information is measured in terms of probability and entropy. To teach coding schemes, including error correcting codes.	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC352B.1	Interpret information theory concepts and compute the capacity of various types of channels.
EC352B.2	Construct various source codes and error correction codes.
EC352B.3	Examine information theory and coding algorithms.
EC352B.4	Estimate various performance parameters of information theory and error correction coding algorithms.
EC352B.5	Survey various error correction codes used in wired and wireless applications.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC352B.1	3											
EC352B.2	3		2		2							
EC352B.3	3		2	2	2				2	2		
EC352B.4	3	3			1							
EC352B.5	1	1			1				1	1		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC352B.1		2				
EC352B.2		2	2			

EC352B.3		2	2	3		
EC352B.4		1				
EC352B.5		1				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	✓ Understand	✓ Apply	✓ Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Information theory and source coding**	1,2	8
	1.1	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and its properties, differential entropy and mutual information kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes.		
	1.2	Source Coding, Shannon's Source Coding Theorem, Huffman Source Coding and its second and third order extensions, Shannon Fano coding, Lempel Ziv coding.		
	1.3	Shannon's Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, AWGN channel and, fading channels, properties of channel capacity, channel coding theorem.		
2		**Linear Block Codes**	1,2	6
	2.1	Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities.		
	2.2	Standard array and Syndrome decoding.		
	2.3	Hamming Codes, Reed – Muller codes, Golay code, Product codes and Interleaved codes.		
3		**Cyclic Codes**	1,2	6
	3.1	Introduction, Generator and Parity check· Polynomials, Systematic Cyclic codes – Encoding and decoding using Feedback shift register circuits and polynomial method.		
	3.2	Generator matrix for Cyclic codes, Syndrome computation and Error detection.		
	3.3	Meggitt decoder, Cyclic Hamming codes, Golay code, Shortened cyclic codes.		

4		**Convolutional Codes**	1,2	8
	4.1	Graphical representation for encoding and decoding using code tree, trellis, state diagram.		
	4.2	Polynomial and time domain method, Viterbi decoding		
	4.3	Introduction to Turbo coding and LDPC codes		
5(Self Study)		Case study (anyone): Golay codes, turbo codes, LDPC codes, Reed Solomon codes, BCH codes		4
			Total	**28**

Laboratory Components:

Sr. No	Title of the Experiment
1	Write a simulation program to test shannon's source coding, channel coding and channel capacity theorem.
2	Write a program to encode and decode a text file and determine the code efficiency using Shannon – Fano coding and Huffman Coding
3	Write a program to construct Lempel Ziv Coding and decoding and examine its code efficiency
4	Write a program to examine BER performance of linear block code for a coded and uncoded BPSK communication system in AWGN channel
5	Write a program to examine BER performance of cyclic codes for a coded and uncoded BPSK and QPSK communication system in AWGN channel
6	Write a program to examine BER performance of BPSK modulated linear block coded communication system in AWGN channel and fading channel
7	Write a program to examine BER performance of convolutional encoder in a coded and uncoded communication system based on 802.11a standard with and without AWGN channel
8	Write a program to examine BER performance of convolutional encoder in a coded and uncoded OFDM system with and without AWGN channel
9	Write a program to examine BER performance of convolutional encoder in a coded and uncoded OFDM system with and without fading channels
10	Simulation either turbo codes/RS codes/ LDPC codes/BCH codes and test their error correction capability.

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Communication Systems	Fourth	Haykin Simon	John Wiley and Sons, New Delhi	2014
2	Modern Digital and Analog Communication Systems	Fourth	Lathi B Pand Ding Z	Oxford University Press	2009

Department of EXTC

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Information Theory and Reliable Communication		R. G. Gallager	Wiley, ISBN-13: 978-0471290483	1968
2	Introduction to Coding and Information Theory		Roman, Steven	Springer, ISBN 978-0-387-94704-4	
3	Error Control Coding	Second	Shu Lin & Daniel J. Costello	Prentice Hall	2004
4	Error Control Systems for Digital Communication and Storage		S. B Wicker	Prentice Hall International	1995
5	Digital Communication: Fundamentals and applications	Second	Sklar B, and Ray P. K	Pearson, India	2009
6	Information theory, Coding and Cryptography		Ranjan Bose	TMH publication, ISBN: 978-0-07-0669017	2008

Bharatiya Vidya Bhavan's
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Department of EXTC

Sem-VII

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-III	Wireless Sensor Network	2	0	2	2	6	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC413		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC307: Computer Communication Networks EC311: Mobile Wireless communication
Course Objective: Wide range of applications such as disaster management, military and security have fueled the interest in sensor networks during the past few years. Sensors are typically capable of wireless communication and are significantly constrained in the number of available resources such as energy, storage and computation. Such constraints make the design and operation of sensor networks considerably different from contemporary wireless networks and necessitate the development of resource conscious protocols and management techniques. This course provides a broad coverage of challenges and latest research results related to the design and management of wireless sensor networks.	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC413.1	Evaluate architecture of sensor networks and its characteristics.
EC413.2	Determine suitable medium access protocols and radio resources.
EC413.3	Devise appropriate data dissemination protocols and acquisition system.
EC413.4	Explore the design space of various supportive OS, its performance, and resources.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC413.1		2										
EC413.2				2								
EC413.3					2							
EC413.4		3			3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC413.1		2				
EC413.2		2				

EC413.3		2				
EC413.4					3	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand✓	Apply✓	Analyze	Evaluate	Create✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Characteristics Of WSN**	1,2	07
	1.1	Characteristic requirements for WSN - Challenges for WSNs – WSN vs. Adhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations, Power, signal processing transmission related constraints		
2	Title	**Medium Access Control Protocols**	1,2	08
	2.1	Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts - Contention-based protocols -Schedule-based protocols - SMAC - BMAC -, 802.11pVehicular IEE std., Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol, Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling.		
3	Title	**Routing And Data Gathering/Acquisition**	1,2	08
	3.1	Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing -Gradient-based routing - Rumor Routing – COUGAR –ACQUIRE – Hierarchical Routing - LEACH, PEGASIS –Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation - data aggregation operations – Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB.		
4	Title	**Embedded Operating Systems**	1,2	05
	4.1	Operating Systems for Wireless Sensor Networks – Introduction RTOS and operation - Operating System Design Issues – Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS -		

		OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM.		
5	**Self-Study**	Security challenges, Threat and attack models, Quality of service provisioning, Clock synchronization, Supporting fault tolerant operation	1,2	***05**
			Total	**28**

Laboratory Components

Lab No	Title of the Lab	Marks	Reference
	Preparatory Lab: Study of Hardware, Software, Middleware with specifications.	--	1,5
1	Embedded/RTOS OS fundamentals	5	5
2	Onboard RTOS environment settings	5	
3	MAC algorithms using NS3	5	
4	MAC algorithms using NetSim, Omnet++	5	
5	Routing algorithms using NS3	5	
6	Routing algorithms using GNS3	5	
7	Virtual Lab	5	4
8	Energy management using NS3	5	
9	QoS using NS3, NetSIM, Omnet++,GNS3, Contiki	5	
10	Build the WSN application using Python Framework (Django) and Cloud environment	5	

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Wireless Sensor Networks Technology, Protocols, and Applications	--	Kazem Sohraby, Daniel Minoli and Taieb Znati	John Wiley and Sons	2007
2	Protocols and Architectures for Wireless Sensor Networks	--	Holger Karl and Andreas Willig	John Wiley and Sons	2005
3	Wireless Sensor Networks	--	Cauligi S. Raghavendra, Krishna Sivalingam, Taieb M. Znati	Springer, ISBN 1-4020-7883	2004
4	A Guide to Wireless Sensor Network	--	A. Swapna Kumar	University Science Press	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	A survey of routing protocols in wireless sensor networks	--	K. Akkaya and M. Younis	Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325—349	--
2.	Tiny OS Programming	--	Philip Levis.	--	--
3.	Wireless Sensor Network- Technology and Applications	--	Edited by Mohammad A. Matin	INTECH	2012

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-4	Next Generation Network	3	0	0	3	6	3	0	0	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC414		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	EC307: Computer Communication Networks EC311: Mobile Wireless communication
Course Objective: To provide a working knowledge of emerging network technologies, how they are used, what their advantages or disadvantages are, and what their future offers. Consider the business potential for current and future services. Summarize architecture and technology options for Multi-Service Networks. Identify the key technologies for core, access and infrastructure.	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC414.1	Describe technical features and design considerations of the next generation networks.
EC414.2	Apply the concept of convergence of service.
EC414.3	Identify the NGN services in business-oriented aspects.
EC414.4	Demonstrate technologies for next generation networks.
EC414.5	Evaluate the performance of Next Generation Networks.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC414.1	3		2									
EC414.2		2										
EC414.3		2										
EC414.4					3							
EC414.5					3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC414.1		2				
EC414.2		2				
EC414.3		2				
EC414.4		2			3	

EC414.5		2				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply✓	Analyze✓	Evaluate✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Next generation Network and ITU standards, IPv6**	1,2	**12**
	1.1	Introduction Evolution of public mobile services - Main drivers to Next Generation Networks – NGN, ITU NGN standards. SG13		
	1.2	All-IP network concept, Numbering, naming, and addressing for all NGN, NGN control architectures and protocols, Transport Stratum, Service Stratum, Service Management, Application Functions. Wireless NG Technologies, 5G networks and small cell types, Integration with services.		
	1.3	Transition of IP networks to NGN, Future packet-based network. IPv6 NGN implementation, NGN business challenges, NGN evaluation.		
2	**Title**	**IMS and Convergent Management IMS Architecture**	2,3	**08**
	2.1	IMS services, QoS Control and Authentication, Network and Service management for NGN, IMS advantages		
	2.2	Next Generation OSS Architecture - standards important to OSS architecture, Information framework, OSS interaction with IMS, NGN OSS function/ information view reference model, DMTF CIM, Push to Talk over Cellular (PoC) Service, MS-Based FMC Service.		
3	**Title**	**NGN Services: Technology, Business Aspects**	2	**08**
	3.1	VoIP, IPTV, rich multimedia, future web, Quality of Service (QoS), Quality of Experience (QoE) in NGN		
	3.2	Control and Signaling protocols for NGN, NGN security, Service convergence, Business, and regulatory aspects of NGN, Ubiquitous Sensor Network Services-USN Functional Architecture, USN Applications, Business models and regulation of the NGN services.		
4	**Title**	**MPLS and VPN Technology**	1,2	**07**
	4.1	MPLS & QoS, MPLS services and components – layer 2 MPLS multicast, IPv6 and MPLS - Technology overview, Future of		

		MPLS – Integrating IP and optical networks, Future Layer2 layer3 services		
	4.2	VPN, layer Internetworking, VPN services, signaling, layer 3 VPN – Technology overview, Remote Access, and IPsec integration with MPLS VPN. VPN services in NGN with emerging Internet of Things (IoT) and Web of Things (WoT)		
5	**Title**	**NGN Management and Future Evaluation**	2,3	**07**
	5.1	Configuration, Accounting, performance, security, case study for MPLS,		
	5.2	Future enhancements – Adaptive self-healing networks, Intelligent Networks, Self-organizing Network (SON)		
6	**Self-Study**	Software Defined Networks (SDN) & NFV, Network Automation and Containerized NFV, IMS Advantages, NEXT GENERATION OSS ARCHITECTURE, Services Implemented on NGN	5,6	**06**
			Total	**42+6**

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Next generation Telecommunication Networks, Services and Management	--	Thomas Plavyk	Wiley and IEEE Press Publications	2010
2	NGN Architectures, Protocols and Services	--	Toni Janevski	John Wiley and Sons	2014
3	Next Generation Network –A Complete Guide	--	Gerardus Blokdyk	5 STAR Cooks	2018

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Next Generation Network Services: Technologies and Strategies	--	Neill Wilkinson	John Wiley Publications	2002
2.	Foundations of Modern Networking-SDN, NFV and QoE, IoT and Cloud	--	William Stallings	Pearson Publications	2015
3.	SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies	--	Thomas D. Nadeau and Ken Gray	Oreilly Publications	2013

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-3	Image and Video Processing	2	-	2	5	8	2	-	1	3
EC423		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC207: Signals and Systems EC303: Digital Signal Processing
Course Objective: To study the image and video fundamentals and mathematical transforms necessary for processing and enhancement techniques. To study image restoration procedures and compression procedures for different applications.	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC423.1	Apply the image fundamentals and mathematical models for digital image and video processing.
EC423.2	Analyze time and frequency domain techniques for image enhancement.
EC423.3	Apply segmentation and compression techniques.
EC423.4	Develop image and video processing applications.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC423.1	3	3										
EC423.2			3	2	3							2
EC423.3					3							
EC423.4	2	2			3	2			3	3		3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC423.1		2					
EC423.2					3		
EC423.3			2				
EC423.4			2			3	

Department of EXTC

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply✓	Analyze✓	Evaluate✓	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Fundamental of Image and Video**	1,6	04
	1.1	Structure of the Human Eye, Light, Brightness adaption and discrimination, Pixels, coordinate conventions,		
	1.2	Imaging Geometry, Image acquisition, sampling and quantization, image resolution, basic relationship between pixels, color images, RGB, HSI and other models		
2	Title	**Two Dimensional Transforms and Image Enhancement**	1,5	06
	2.1	Discrete Fourier Transform, Discrete Cosine Transform, KL Transform, and Discrete Wavelet Transform		
	2.2	Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, smoothing filters, sharpening filters, gradient and Laplacian, Frequency domain filtering.		
3	Title	**Image Segmentation and Compression**	1,5	05
	3.1	Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region-based segmentation, Morphological operations.		
	3.2	JPEG and MPEG compression standard, H.265 video compression standard		
4	Title	**Image Restoration**	1,6	04
	4.1	Basic Framework, Image degradation model, Noise characterization, Noise restoration filters,		
	4.2	Adaptive filters, and Estimation of Degradation functions, Restoration Techniques.		
5	Title	**Video Formation and Representation**	2,3	05
	5.1	Digital Video Sampling, Video Frame classifications, I, P and B frames, Notation		
	5.2	Video Capture and display: Principle of color video camera, video camera, digital video Sampling of video Signals: Required sampling rates, sampling in two dimensions and three dimensions, progressive virus interlaced scans		
6	Title	**Motion Estimation**	2,3	04
	6.1	Optical Flow: Motion Vs optical flow, optical flow equations, motion representation, motion estimation criteria, optimization		

		method.		
	6.2	Pixel based motion estimation, Block Matching Algorithms, Multi resolution Motion Estimation: General formulation.		
7	**Self-Study**	Study of different format of image and video, Basics of image and video terminology, ITU-RBT 601, Digital Video formats, Digital video quality measure.		
			Total	**28**

Laboratory:

Sr. No	Title of the Experiment
1.	Image Enhancement
2.	Image Transformations.
3.	Image Filtering
4.	Image Segmentations
5.	Image Compression
6.	Image Restoration
7.	Object Detection in video
8.	Motion Estimation on video
9.	Color Image Segmentation
10.	Discrete Wavelet Transforms on image

Textbook

Sr. No	Title	Edition	Authors	Publisher	Year
1	Computer Vision and applications-A Guidefor Students and Practitioners	First	Bernd Jahne and Host Hau Becker	Elsevier	--
2	Digital Image and Video Processing	First	Dhananjay Theckedath	Pearson Education	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Image Processing	Third	Rafael C. Gonzalez and Richard E. Woods	Pearson Education	2010
2	Digital Video Processing	Second	Murat Tekalp	Pearson Education	2010
3	Handbook on Image and Video Processing	---	A. I. Bovik	Academic Press	2009

Department of EXTC

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE- 4	Principles of Soft Computing	2	0	2	6	8	2	0	1	3
EC424		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MA101: Engineering Calculus MA102: Differential Equations and Complex Analysis
Course Objective: To implement soft computing-based solutions for solving real-world problems	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC424.1	Identify soft computing techniques and their roles in building intelligent Machines.
EC424.2	Apply fuzzy logic reasoning to build model for solving various engineering problems.
EC424.3	Analyze optimization issues using Genetic Algorithm.
EC424.4	Design various hybrid soft computing models by using different techniques.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC424.1	2	2			3							
EC424.2		2	2		3							
EC424.3			2		3							
EC424.4				2	3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC424.1	2			2	2	
EC424.2	2			2	2	
EC424.3	2				2	
EC424.4		3			2	3

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction To Soft Computing and Neural Networks**	1,2	**04**
	1.1	Introduction to Soft Computing, Difference between Hard and Soft Computing. Conventional AI, Computational Intelligence		
2	Title	**Neural Networks**	1,2	**10**
	2.1	Biological neuron, Artificial Neuron Model, Single layer Multilayer Architecture of Neural Networks Architecture, Activation functions, Learning rules.		
	2.2	Supervised Learning Neural Network: Back Propagation Network, Radial Basis Function Network.		
	2.3	Unsupervised Learning Neural Network: Adaptive Resonance Architecture.		
3	Title	**Fuzzy Logic**	3	**6**
	3.1	Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations		
	3.2	Membership Functions, Fuzzy Rules, and Fuzzy Reasoning		
	3.3	Fuzzy Inference Systems, Fuzzy Models.		
4	Title	**Genetic Algorithm**	3	**8**
	4.1	Introduction to Genetic Algorithm, Working Principle of Genetic Algorithm.		
	4.2	Various Encoding methods, Fitness function.		
5	Self-Study	Analyse advanced soft computing techniques.		
			Total	**28**

Laboratory Component

Sr. No	Title of the Experiment
1	Linear & Nonlinear analysis using single &multiplayer neural network
2	Supervised learning neural network
3	Unsupervised learning neural network
4	Fuzzy logic operations
5	Fuzzy system design
6	Genetic Algorithm
7	Design Neuro-fuzzy model
8	Hybrid Design/Expert system Design

Department of EXTC

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Artificial Neural Systems	--	Jacek M. Zurada	PWS Publishing Company	1995
2	Principles of Soft Computing	Third	S. N. Sivanandamand S. N. Deepa	Wiley Publication,	2018
3	Neural Networks, Fuzzy Logic, and Genetic Algorithms	--	S. Rajasekaran and G. A. Vijayalakshami	Prentice-Hall of India	2004

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Neural Networks: A Comprehensive Foundation	--	Simon Haykin	Macmillan College Publishing Company	1994
2	Neural Network Design	--	Martin Hagan	CENGAGE Learning, India	2008
3	Fuzzy Sets and Fuzzy Logic: Theory and Applications	--	George J. Klir and Bo Yuan	Prentice-Hall of India	1994

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-III	Real Time Operating Systems	2	--	2	5	9	2	--	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC433		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	ET201: Computer Architecture and Organization ET206: Microcontrollers IT12: Embedded System
Course Objective: To impart students the fundamentals of Operating Systems and provide the knowledge on the implementation aspects of real time concepts.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
EC433.1	Demonstrate the basic concept of OS and configure the System.
EC433.2	Analyze different types of scheduling algorithms with given application
EC433.3	Apply kernel Services and Synchronization
EC433.4	Evaluate memory management strategies

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC433.1	2	2	2	3				2		2		
EC433.2	2	2	2	3				2		2		
EC433.3	2	2	2	3				2		2		
EC433.4	2	2	2	3				2		2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC433.1						
EC433.2		1	1			
EC433.3		1	1			
EC433.4		1	1			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	Understand ·	Apply ·	Analyze ·	Evaluate	Create

Department of EXTC

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**OS Fundamentals**		06
	1.1	Operating system objectives and functions, Evolution of OS, Characteristics of modern OS	1,2	
	1.2	Basic concepts: Task, Processes, Files,System calls, Shell, I/O management, Architecture of OS (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures)	1,2	
	1.3	Batch, Multi programming, Multitasking, Multiuser, parallel, distributed & real –time O.S	1,2	
	1.4	Real time issues, soft and hard real time services	4,5	
2	Title	**Scheduling**		08
	2.1	Need of scheduling, Scheduling algorithms: FCFS, SJF, Priority, Round Robin, RMS	4,5	
	2.2	UNIX Multi-level feedback queue scheduling, Thread Scheduling, Multiprocessor Scheduling concept	3	
3	Title	**Task / Process Management**		08
	3.1	Concurrency: Principles of Concurrency, Mutual Exclusion, H/W Support, software approaches, Semaphores and Mutex, Message Passing techniques	4,5	
	3.2	Deadlock: Principles of deadlock, Deadlock Detection, Deadlock Prevention, Deadlock Avoidance, An Integrated Deadlock Strategies.	4,5	
4	Title	**Memory Management**		06
	4.1	Memory Management requirements, Memory partitioning: Fixed, dynamic partitioning	2,3	
	4.2	Memory allocation Strategies (First Fit, Best Fit, Worst Fit, Next Fit), Fragmentation, Swapping, Segmentation, Paging, Virtual Memory, Demand paging	2,3	
	4.3	Page Replacement Policies (FIFO, LRU, Optimal, clock), Thrashing, Working Set Model	2,3	
5	Self Study	**Case Studies**		
	5.1	Comparison and study of RTOS: RT Linux, Vx works, µ COS and Free RTOS	3,4, 6, 7	
	5.2	RTOS for Industrial Control System (ICS)		
			Total	**28**

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Laboratory Component

Sr. No.	Title of the Experiment*
1	Basic commands of LINUX, User management and Booting process
2	Process management in LINUX
3	Advanced bash Shell scripting in LINUX
4	Memory management in LINUX
5	Configure network interface in LINUX
6	Comparing Foreground background and Task management system in µ COS/ Free RTOS
7	Scheduling of Task in µ COS/ Free RTOS
8	Task Synchronization using semaphores in µ COS/ Free RTOS
9	Resource protection using mutex in µ COS/ Free RTOS
10	Task Synchronization using message queue and mailbox in µ COS/ Free RTOS

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Operating Systems: Internals and Design Principles	8th Edition	William Stallings	Pearson	
2	Modern Operating System	4th Edition	Andrew S. Tanenbaum, Herbert Bos	Pearson	
3	The Design of the UNIX Operating System		Maurice J. Bach	Prentice Hall	
4	Embedded System: Architecture, Programming and Design		Rajkamal	Tata McGraw-Hill Education	2011
5	Introduction to Embedded Systems		Shibu K. V.	Tata McGraw-Hill Education	2017
6	Mastering the FreeRTOS™ Real Time Kernel, A Hands-On Tutorial Guide		Richard Barry		2016
7	MicroC/OS-II: The Real Time Kernal		Jean J. Labrosse	CRC press	05 Feb 2002

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Analog CMOS VLSI Design	3	--	--	5	8	3	--	--	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
EC434		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	ET101: Basic Electrical Engineering EC101: Digital Systems and Microprocessors ET202: Electronic Devices ET205: Analog Circuits PE-1T11: Digital CMOS VLSI Design

Course Objective: This primary goal of this course is to impart knowledge related to basic building blocks of CMOS analog circuits. This course will make students aware of technological challenges offered by scaled technologies coupled with multiple trade-offs in analog design. This course is expected to build analytical skills related to CMOS analog design among the students. Knowledge of fundamentals of MOSFET and CMOS Digital VLSI design is a must to understand this course in a better manner.

Course Outcomes (CO): After successful completion of the course, student will be able to

EC434.1	Recognize trade-offs involved in analog VLSI Circuits
EC434.2	Analyze current mirrors and bandgap references
EC434.3	Analyze single stage amplifier using small signal model as well as large signal methodology
EC434.4	Analyze MOSFET based differential and operational amplifier

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC434.1	3											
EC434.2		3										
EC434.3		3										
EC434.4		3										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

Department of EXTC

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC434.1	1	2	2			
EC434.2	1	2	2			
EC434.3	1	2	2			
EC434.4	1	2	2			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ·	Understand	Apply ·	Analyze · √	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	**CMOS analog building blocks**	1	08
	1.1	Necessity of CMOS analog design		
	1.2	**MOS Models:** Structure of MOSFET, Review of characteristics of MOS device, Second order effects, MOS small signal model, MOS spice models		
2	Title	**Current Mirrors and Bandgap References**	1	08
	2.1	**Passive and Active Current Mirrors:** Basic current mirrors, Cascode current mirrors and Active current mirrors		
	2.2	**Band Gap References:** General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing		
3	Title	**Single Stage Amplifiers**	1	10
	3.1	Basic concepts, Common source stage: resistive load, diode-connected load, current-source load, triode load and source degeneration		
	3.2	Source follower, Common gate stage, Cascode stage		
4	Title	**Differential Amplifiers**	1	06
	4.1	Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads and Gilbert cell		
5	Title	**MOS Operational Amplifiers**	1,2,3	10
	5.1	**Op-amp:** General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Boosting, Common-		

		mode feedback, Input range limitations, Slew Rate, Power supply rejection		
	5.2	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps		
			Total	**42**

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
01	Design of Analog CMOS Integrated Circuits	1st Edition	B Razavi	Tata McGraw Hill	2017
02	CMOS Circuit Design, Layout, and Simulation	Student Edition	R. Jacaob Baker, Harry W. Li, David E. Boyce	Wiley	2009
03	CMOS Analog Circuit Design	3rd Edition	P. E. Allen and D. R. Holberg	Oxford University Press	2016

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Energy Storage Systems in EV Applications	2	-	2	3	7	2	-	1	3
		Examination Scheme								
EC443		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Objectives:

(1) To learn the characteristics and specifications of major Energy storage apparatus being used and explored in EV Applications such as Batteries, Super-capacitors and Fuel Cell (2) To be able to analyze and design the commonly used Battery charger circuits for EV Applications (3) To know various national and international battery charging standards and protocols.

Course Content:

Module-1 Batteries and Fuel Cells

Li-Ion Battery characterization and testing systems & Battery life cycle, Modular battery packs, design, packaging, thermal control and legislative implications. Super-capacitors : Materials and Construction, Basic Model, Specific Behavior of Supercapacitors, Hydrogen Generation and Storage of Hydrogen, Conversion from Hydrogen to Electricity, Power Needed for the Fuel Conditioning, Efficiency of the Fuel Cells, Overall Efficiency.

Module-2 Battery Management System:

Need of BMS, Concept of Battery Cell Balancing and strategies, Passive and Active cell Balancing circuits, BMS hardware Design, BMS hardware Protection, BMS Software Strategies, Intelligent Cell Balancing Algoritms, Monitoring and Protections, Charging and Discharging Management, Diagnostics and testing, Communication

Module-3: Battery Charging Standards and Protocols:

AC Charging: Bharat EV Charger AC-001, DC Charging: Bharat EV Charger DC-001, Home Charging: AC Charging with Single Phase 230V/15A supply, Public Charging AC-001: AC Charging with three Phase 415V AC supply Mains, Public Charging DC-001, Fast Charging for high voltage EVs: Combined charging system CCS-2 and CHAdeMo with ratings from 50kW to 150kW and DC voltages ranging from 400Vto 950V DC.

Course Projects and Lab Work:

(a) battery materials; (b) novel thermal management system for maintaining temperature uniformity among the cells and restrict the rise of maximum temperature above normal conditions; (c) Digital twin based on IoT; sensors; cloud computing; multi-physics modelling and machine learning for real-time monitoring of SoC and SoH of batteries under dynamic discharge conditions;(d) aging controlled fast charging of batteries by evaluation of optimal charging current, and simultaneously optimizing charging time and capacity.

References:

1. Energy Storage by Robert A. Huggins, Springer Publication
2. Energy storage (A new approach) by Ralph Zito Wiley Publication
3. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, The Fairmont Press Inc., 7th Edition.
4. Energy Management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition,Georgia.
5. Energy Storage Systems, Alfred Rufer, CRC Press

Additional References:

1. Z. Zhang, H. Gui, D. Gu, Y. Yang and X. Ren, "A Hierarchical Active Balancing Architecture for Lithium-Ion Batteries," in *IEEE Transactions on Power Electronics*, vol. 32, no. 4, pp. 2757-2768, April 2017.
2. M. Daowd, N. Omar, P. Van Den Bossche and J. Van Mierlo, "Passive and active battery balancing comparison based on MATLAB simulation," *2011 IEEE Vehicle Power and Propulsion Conference*, Chicago, IL, 2011, pp. 1-7.
3. M. Caspar, T. Eiler and S. Hohmann, "Systematic Comparison of Active Balancing: A Model-Based Quantitative Analysis," in *IEEE Transactions on Vehicular Technology*, vol. 67, no. 2, pp. 920-934, Feb. 2018.
4. Xiaoqiang Zhang†, Weiping Zhang, and Geyang Lei," A Review of Li-ion Battery Equivalent Circuit Models," in *TRANSACTIONS ON ELECTRICAL AND ELECTRONIC MATERIALS*, Vol. 17, No. 6, pp. 311-316, December 25, 2016
5. Min Chen, Student Member, IEEE, and Gabriel A. Rinc´on-Mora, Senior Member, IEEE," Accurate Electrical Battery Model Capable of Predicting Runtime and I–V Performance ",in*IEEE TRANSACTIONS ON ENERGY CONVERSION*, VOL. 21, NO. 2, JUNE 2006
6. Jian Cao, Nigel Schofield and Ali Emadi," Battery Balancing Methods: A Comprehensive Review ", in *IEEE Vehicle Power and Propulsion Conference* (VPPC), September 3-5, 2008

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Power Electronic Converters in EV Applications	2	-	2	3	7	2	-	1	3
EC444		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Course Content:

Module-1 Battery Chargers

Types of EV Chargers, On board Chargers, DC Fast Chargers, PF Improvement strategies and Control, DC-DC Converter design and Control Scheme. Topology Selection, Control Method for Fast Charger, Charger Converter Hardware Design, Magnetics Design and Selection, Charger Converter Software Design, Enclosure and Connectors, Thermal Engineering.

Module-2 EV Traction Drive and Control

Motor Selection and types, Torque/Speed curve of different motor types and their comparison, Motor Inverter hardware Design, MOSFET/IGBT Selection, Gate Driver Circuit Design, Power Supply and Controller Hardware, Motor Inverter Software Strategies for control of BLDC Motor Drive and Induction Motor Drive, Motor Inverter Thermal Engineering, Connectors and Wiring, Active and Passive Discharge (in case of DC Bus > 60V). EMI/EMC Standards Introductions

Module-3: DC-DC converter Unit for EV Ancillary Power System

Power Converter Topology Selection, Control Method for DC-DC converter, Hardware Design, Magnetics Design and Selection, DC-DC Converter Software Design, Enclosure and Connectors, Thermal Engineering, Active and Passive Discharge, EMI/EMC Standards Introductions

Case Studies: (To be covered in Practical Session)

Design and development of high-power density power electronics converters, onboard chargers, machines for electric vehicles, power train technology and various controllers for drives and converters. Development of various novel control algorithms for converters and motor drives

References:

1. Chang Liang Xia,"Permanent Magnet Brushless Dc Motor Drives and Controls" Wiley 2012.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2011.
3. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education, second Edition, 2003.

4. Dubey. G.K., "Thyristorised power controllers", New age International, New Delhi, 2002.
5. Bhimbhra P.S., "Power Electronics", Khanna Publishers, New Delhi, 2005
6. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
7. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989.
8. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford,
9. Robert .L.Boylsted,and Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education,9th edition,2009.
10. David A Bell, "Fundamentals of Electronic Devices and Circuits", Oxford University Press, 2009.
11. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 2nd Edition, New Age International Publishers, 2003

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Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-3	Optical Fiber Communication	2	0	2	6	11	2	0	1	3
EC453		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	AS101: Engineering Physics EC304: Electromagnetic Waves
Course Objective: The objective of the course is to provide an understanding of usage of optical fiber for communication.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
EC453.1	Apply EM Wave theory to understand nature of Optical Signal and their corresponding guiding structures.
EC453.2	Identify Passive Optical Components, Sources and Detectors.
EC453.3	Analyze Passive Optical Components, Sources and Detectors.
EC453.4	Evaluate losses in the optical systems.
EC453.5	Compare different Optical Networks.
EC453.6	Design optical Link Budget system.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC453.1	3	3	3	1	3					3		
EC453.2	2	2	2	2	3					3		
EC453.3	2	2	2	2	3					3		
EC453.4	2	2	2	2	3					3		
EC453.5	2	2	2	2	3					3		
EC453.6	3	3	3		3					3		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC453.1		2			2	
EC453.2		2			2	
EC453.3		2			2	
EC453.4		2			2	
EC453.5		2			2	
EC453.6		2			1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Optical communication fundamentals**	1	10
	1.1	Block diagram of Optical Communication system, advantages, loss and bandwidth window, ray theory transmission, total internal reflection, acceptance angle, numerical aperture, skew rays and meridional rays		
	1.2	EM waves, modes in planar guide, phase and group velocities, types of fibre according to refractive index profile and mode transmission.		
	1.3	Couplers, Isolators, circulators, multiplexers, filters, fibre gratings, Fabry Perot filters, arrayed waveguide grating, switches and wavelength converters		
2		**Optical communication Components**	1	08
	2.1	Sources (LED, LASER), Detectors (PIN, APD) and Amplifiers		
3		**Optical Networks and losses in the system**	1	10
	3.1	Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion, dispersion and pulse broadening, dispersion shifted, and dispersion flattened fibers, and nonlinear effects Measurements of attenuation, dispersion and OTDR		
	3.2	Optical Networks: Link budget, SONET, SDH, WDM, DWDM		
4(Self Study)		**Review of latest optical fiber application and research**		06
			Total	**28**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Setup of Optical fiber communication link and measurement of Bit Error Rate (BER) and Eye pattern analysis A) Setup of analog fiber optic communication link B) Setup of digital fiber optic communication link C)Measurement of Bit Error Rate D)Study and measurement of Eye pattern
2	Measurement of Numerical Aperture (NA) of optical fiber
3	Measurement of Losses in Optical Fiber
4	Study characteristic of LED and Photo detector in optical fiber communication link.
5	To verify the Brewster's law and to find the Brewster's angle

6	Michelson's Interferometer- Refractive index of glass plate: To determine the refractive index of a thin glass plate.
7	To Demonstrate the working of LASER using Phet virtual Lab
8	Measure propagation loss in plastic fiber and to measurethe bending loss.
9	Plotting optical link power budget.
10	Mini project on optical network.

Textbooks:

S. N.	Title	Authors	Edition	Publisher	Year
1	Optical Fiber Communication	John M. Senior	Fourth	Prentice Hall of India Publication	2013
2	Optical Fiber Communication	Gred Keiser	Third	Mc-Graw Hill Publication	2012
3	Optical Networks: A Practical Perspective	Rajiv Ramaswamy and Kumar N. Sivarajan	Third	Elsevier Publication	2010

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-4	Telecom Network Operations and Management	2	0	2	2	6	2	0	1	3
EC454		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	EC307: Computer Communication Network
Course Objective: To develop understanding the concept of Telecommunication network management, architecture, and protocol. Appreciate the need for interoperable network management. This course offers students a hands-on experience managing network hardware and essential network services such as DHCP, DNS, ARP, FTP, Telnet, HTTP, SSH, SMTP, TFTP, and SNMP using scripting and python programming.	
Course Outcomes (CO): At *the end of the course students will be able to*	
EC454.1	Identify network requirements and apply the concept of structured wiring, structured Network Design and select the best solutions to meet the needs of a business.
EC454.2	Analyze the network management standards and protocols to support FCAPS Model of Network Management.
EC454.3	Identify the functions of the Network Manager and show how management information is stored & accessed within a managed object.
EC454.4	Apply effective troubleshooting and debugging techniques to resolve the network problems.
EC454.5	Apply fundamental components of Network Management and implement server and agent architectures to monitor and control networks, devices and applications.
EC454.6	Develop programs in Python to solve real problems in Network Management.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EC454.1			2	2								
EC454.2			2	2								
EC454.3					3							
EC454.4					3							
EC454.5					3							
EC454.6					3							

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CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
EC454.1			2			
EC454.2		2				
EC454.3			2			
EC454.4		2		3	2	
EC454.5			2		3	
EC454.6		2			2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	✓ Apply	✓ Analyze	✓ Evaluate	✓ Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction to Enterprise Network Design**	2,1,3	08
	1.1	Introducing Network Design Concepts: Medium Enterprise Design Profile (MEDP)—LAN Design, LAN design principles, LAN design model for the medium enterprise, Considerations of a multi-tier LAN design model for medium enterprises, Designing network foundation services for LAN designs in medium enterprise, Scalability, Service uptime, WAN Design, Business, and network-based economy.		
	1.2	Challenges of IT managers, Network management architecture and organization network management perspectives management: Goals, organization, and functions		
2	Title	**OSI Network Management**	1,2,3	02
	2.1	Network management standards, Network management models, Organization model, Information model Communication model and functional model, Abstract syntax notation – encoding structure, macros, functional model CMIP/CMISE		
3	Title	**Internet Management (SNMP)**	1,2,3	08
	3.1	SNMP-organizational model-System overview. Information model, communication model, functional model, SNMP proxy server, Management information, Protocol SNMPv1,v2 and V3,		

		Remote monitoring. RMON, Limitations of SNMP, Beyond SNMP, NETCONF/YANG		
4	**Title**	**Telecommunication Management Networks (TMN)**	1,2.3	**03**
	4.1	Need for TMN, Conceptual TNM model, TMN Network Management Architecture, TMN management services architecture and TMN implementation		
5	**Title**	**Network Management Tools and Applications**	1,4,5	**07**
	5.1	System Utilities for network management, Network statistics and measurements, NMS Design, NMS components, NMS Server Architecture, Network Management Systems and FCAPS, Automatic Fault Management and Event correlation Techniques, Security Management		
6	**Self Study**	**Broadband Network Management:** ATM Network Management and Wireless Network Management		**04**
			Total	**28**

Laboratory Component

Sr. No	Title of the Experiment
1	Network Monitoring tools: a) Status b) Routec) Traffic Tools d) Audit
2	Monitoring and management network using SNMP: a) Basic SNMP b) Advanced SNMP v3 Authentication/Encryption and ACL c) SNMP Trap Daemon Implementation
3	Configuration SNMP Protocol on Cisco Router using Packet Tracer
4	Configuration manageable Switch: L2/L3 Switch
5	LAN Troubleshooting using tcpdump and Wireshark
6	Monitoring of services and Servers using a) Observium/ Cacti b) Nagios/Icinga
7	Implementation of Centralized Logging infrastructure and security event correlation
8	Open Source SIEM Project
9	Python scripts for Network Monitoring
10	Network Management using Python

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Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Network Management Principles and Practice	--	Mani Subramaniam	Addison Wisely, New York	2000
2	Designing and Supporting Computer Networks, CCNA Discovery Learning Guide	--	Kenneth Stewart, Aubrey Adams, Allan Reid, Jim Lorenz	Cisco Press	---
3	Network Management: Concepts and Practice, A Hands-On Approach	--	J. Richard Burke	Pearson Publications.	--
4	Network Management: Accounting and Performance Strategies	--	Benoit Claise- CCIE No. 2686; Ralf Wolter	Cisco Press	--
5	Network Management Fundamentals	--	Alexander Clemm	Cisco Press, ISBN-13: 978-158720137	2006
6	Python for Software Design	--	Allen B. Downey	Cambridge University Press ISBN-13: 978-0521725965	2009

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai)
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Department of EXTC

Sem-VIII

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PROGRAM ELECTIVE COURSES

- 4 Electives are sufficient to specialize in a particular vertical/thread/area.

TD/ PE	PE1	PE2	PE3	PE4	PE5 / PE6
THREAD 1: **Communication**	**T11:** Mobile and Wireless communication	**T12:** Microwave Communication	**T13:** Wireless Sensor Networks	**T14:** Next Generation Network	**Two courses from the following list** **T11, T12, T21, T22, T31, T32, T41, T42, X, Y**
THREAD 2: **Signal Processing**	**T21:** Speech and Audio Processing	**T22**: DSP Processors	**T23:** Image & Video Processing	**T24:** Principles Soft Computing	
THREAD 3: **VLSI & Embedded Systems**	**T31:** Digital CMOS VLSI Design	**T32:** Embedded Systems	**T33:** Real Time Operating Systems	**T34:** Analog CMOS VLSI Design	
THREAD 4: **Power Electronics and Energy Systems**	**T41:** Power Electronic Converters (Cat2) IC & MEMS Technology (Cat1)	**T42:** Embedded System Design for Power Converter Applications	**T43:** Energy Storage Systems in EV Applications	**T44:** Power Electronic Converters in EV Applications	
GENERAL	**X** Network Fundamentals (Cat2) Any other PE1 (Cat1)	**Y:** Fundamentals of Antenna (Ct2) Information Theory and Coding (Ct1)	**P:** Optical fiber Communication	**Q:** Telecomm Network Operations & Management	
	T11, T12, T21, T22, T31, T32, T41, T42	T11, T12, T21, T22, T31, T32, T41, T42			

*For Open Elective courses refer to the document: "Open Elective Syllabus"