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

B. Tech. (Electronics and Telecommunication Engineering)

Syllabus
(Semester III-IV)

2025 Iteration (w.e.f. 2025-26)

Nomenclature of the Courses

Abbreviation	Course Category
BSESC	Basic Science & Engineering Science Courses
BSESEC	Basic Science & Engineering Science Elective Courses
SEC	Skill Enhancement Course
AEC	Ability Enhancement Course
HSSMC	Humanities and Social Science in Management Courses
CC	Cocurricular Courses
IKS	Indian Knowledge System
UHV	Universal Human Values
PCC	Program Core Courses
PEC	Program Elective Courses
OEC	Open Elective Courses
ELC	Experiential Learning Courses
MDM	Multidisciplinary Minor
CP	Community Project
HC	Honor Courses
DMC	Double Minor Course

Abbreviations

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

SEM III										
Sr. No	**Course Category**	**Abbreviation**	**Course Code**	**Course Name**	**L**	**T**	**P**	**O**	**E**	**C**
1	Basic & Engg. Sciences	BSES	MA201	Linear Algebra	2	0	2	5	9	3
2	Basic & Engg. Sciences *	MT	MA202	Fundamentals of Mathematics-I*	2	1	0	0	3	3
3	Skill Enhancement Course #	SEC	AS201	Professional Communication Skills	1	0	2	2	5	2
4	Basic & Engg. Sciences Elective	BSESE		**Course III**						3
			AS101	Engineering Physics/	2	0	2	4	8	
			AS102	Engineering Chemistry/	2	0	2	3	7	
			AS103	Biology for Engineers/	3	0	0	3	6	
			AS104	Engineering Mechanics/	2	0	2	4	8	
			AS105	Engineering Graphics/	0	1	2+2	2	7	
			AS108	Material Science/	3	0	0	4	7	
			AS109	Environmental Science/	3	0	0	3	6	
			AS110	Energy Science/	3	0	0	3	6	
			AS111	Thermal & Fluid Engineering/	3	0	0	3	6	
5	Humanities	HSSM-I	HS2XX	**Course I**	2	0	0	3	5	2
6	Program Core Courses (12)	PCC	EC201	Electromagnetic Wave Engineering	3	0	2	5	7	4
7		PCC	EC202	Electronic Devices and Circuits	3	0	2	4	9	4
8		PCC	EC203	Signal, Network and System	3	0	2	4	9	4
9	Co-curricular Courses	CC (LLC)	LLC03	LLCXX	0	1/0	0/2	2	3	1
				Total	**14**	**2**	**12**	**30**	**57+**	**23**

**Only for Lateral Entry Students*
 # No MSE and ESE exam

SEM IV										
Sr. No	**Course Category**	**Abbreviation**	**Course Code**	**Course Name**	**L**	**T**	**P**	**O**	**E**	**C**
1	Basic & Engg. Sciences	BSES	MA203	Probability and Stochastic Process	3	0	0	6	9	3
2	Basic & Engg. Sciences *	MM	MA204	Fundamentals of Mathematics-II*	2	1	0	0	3	3
3	Skill Enhancement Course #	SEC	AS202	Hardware Description Language programming	1	0	2	2	5	2
4	Humanities	HSSM-II	HS2XX	**Course II**	2	0	0	3	5	2
5	Program Core Courses (11)	PCC	EC205	Analog and Digital Communication	3	0	2	4	9	4
6		PCC	EC206	Computer Organization & Architecture	3	0	0	4	7	3
7		PCC	EC207	Mixed Signal Integrated Circuit	3	0	2	4	9	4
8	Cocurricular Courses	CC (LLC)	LLC04	LLCXX	0	1/0	0/2	2	3	1
9	Multidisciplinary Minor	MDM	MDEC1X	MDM-I	To be defined by others					3
				Total	**14**	**1**	**6**	**27**	**49+**	**22**

 # No MSE and ESE exam

Summer term (For Lateral Entry Students)										
Sr. No	**Course Category**	**Abbreviation**	**Course Code**	**Course Name**	**L**	**T**	**P**	**O**	**E**	**C**
1	Basic & Engg. Sciences	BSES	MA201	Program Specific Maths-I – Linear Algebra	2	0	2	5	9	3
2	Basic & Engg. Sciences	BSES	MA203	Program Specific Maths-II --- Probability and Stochastic Process	3	0	0	6	9	3

- **Students are expected to start working for the Mini Project I during the summer.**
- **Research internship of minimum 2 months for the "Honors by Research" for 6 credits- HR21 (Not for DSY)**
- **For Enrollment to Honors by research, Minimum CGPA must be 8.25**

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B. Tech. EXTC

Semester-III

Course (Category) Code	Course Name	Teaching Scheme (Hours/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	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisites Course Codes, if any.	Engineering Calculus/Foundation of Mathematics-I and Differential Equations and Complex Analysis/Foundation of Mathematics-II
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 a matrix.
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 and solve systems of differential equations using diagonalizable 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											
MA201.4	3											
MA201.5	3											
MA201.6	1	2										

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA201.1	1					
MA201.2						
MA201.3	1					
MA201.4						
MA201.5						
MA201.6					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**	**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, Normal form.		02
2	**Title**	**Linear equations & its solutions**	**1,2,3,5**	**06**
	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		03
3	**Title**	**Vector spaces (over field of real numbers)**	**1,2,5**	**10**
	3.1	Vector space, subspace, span, linear dependence and independence of vectors, basis, dimension, Introduction to		10

		Orthogonalisation, Orthonormal basis, orthogonal projection & Gram-Schmidt process. Null space, row space, column space, Rank-Nullity theorem (only statement).		
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**	**07**
	5.1	Eigenvalues, Eigenvectors and its properties. Cayley Hamilton theorem and its applications. Diagonalisation of matrices. Derogatory and Non-derogatory matrices.		04
	5.2	Functions of a square matrix. Solving system of differential equations using diagonalisation, Singular Value Decomposition		03
6	**Self-Study**	2.2 Forming equations using KVL for circuits and solving them using matrices. 3.1 Least square method 3.1 Linear Transformation of matrix. 5.1 Additional properties with proofs of eigenvalues and eigenvectors.	**1,2,3,5**	05*
			Total	**28**

***Total of 28 hours does not include the self-study hours.**

Laboratory Component (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 Eigenvalues and Eigenvectors using Scilab

Text Books

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

Reference Book

Sr. No	Title	Edition	Authors	Publisher	Year
1	Linear Algebra and its applications	Third	David. C. Lay	Pearson Education	2006
2	Elementary Linear Algebra Application Version	Sixth	H Anton and Crorres	John Wiley and Sons	2010
3	Advanced Engineering Mathematics	Twenty Eighth	H.K Das	S.Chand	2014
4	Hill Ciphers	First	Jonaki B Ghosh	At Right Angles	2015
5	Advanced Engineering Mathematics	Tenth	Erwin Kreysizg	John Wiley & Sons	2011
6	Linear Algebra with Applications	Sixth	Keith Nicholson	Lyrvx	2009

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	0	3	2	1	0	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)		Total	
MA202		Theory	20		20		60		100	
		Laboratory	--		--		--		--	

Pre-requisite Course Codes, if any.	Basic Engineering Mathematics at first year of Diploma.
Course Objective: To develop basic foundation of mathematical skills.	
Learning Outcomes (LO): ***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	1											
MA202.4	2											
MA202.5	2											
MA202.6	1											

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA202.1						
MA202.2	1					
MA202.3						
MA202.4						
MA202.5	1					
MA202.6	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	**Differential Calculus**	1,2	**18**
	1.1	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	Forty Forth	Dr. B. S. Grewal	Khanna Publications	2020

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Engineering Mathematics	Tenth	Erwin Kreysizg	John Wiley & Sons	2011
2	Advanced Engineering Mathematics	Twenty Eighth	H.K.Dass	S. Chand Publications	2014
3	Advanced Engineering Mathematics	Fourth	Jain and Iyengar	Narosa Publications	2014

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SEC	Professional Communication Skills	1	0	2	2	5	1	0	1	2
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
AS201		Theory	--		--		--			---
		Laboratory	100		--		--			100

Pre-requisite Course Codes, if any.	AS107 – Soft Skills 1
Course Objective: To demonstrate the desired spoken and written communication skills required in early professional life, with focus on job placements.	
Learning Outcomes (LO): ***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.
AS201.1	Demonstrate the spoken and written skills for job placements.

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	3		
AS201.2										3		
AS201.3								3	2			

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
AS201.1		3				2
AS201.2		3				2
AS201.3				3		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	**Placement Skills**		4
	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
	2.1	Presentation Skills		
	2.2	Meeting: Notice, Agenda, Minutes		
	2.3	Proposal Writing		
	2.4	Report Writing: Informative, Analytical and Technical report. Use of LaTeX for writing reports (Overleaf)		
	2.5	Originality and Plagiarism: Ethics of writing		
3	Title	**Leadership Skills and Professional Ethics**		4
	3.1	Principles and Styles of Leadership		
	3.2	Motivating and inspiring team members		
	3.3	Decision-making and problem-solving skills		
	3.4	Time and Stress management		
	3.5	Workplace etiquettes		
4	Self - Study	**Research Writing** Research Paper, News Analysis, Blog Writing		6*
			Total (*Not included)	**14L + 28P = 42 hrs**

Tutorial Component:

Sr. No.	Title of the Experiment	Marks	Duration (Hrs)
1	Resume	20	2
2	Cover Letter	20	2
3	GD	20	2
4	Mock Interview	20	3
5	Presentation	20	2
6	Decision-making and problem-solving activity	20	2
7	Minutes of the Meeting/Notice & Agenda	20	2
8	Proposal Writing	20	2
9	Report Writing	20	2
10	Case studies on ethical issues in engineering	20	2
11	Team Building Activity	--	2
12	Research Article Writing	--	2
13	Use of Plagiarism checker (e.g. Turnitin)	--	1
14	Self and Team Motivation Activities	--	2
Total		**200 Marks**	**28 Hrs**

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

For Additional Reading:

- **Teamwork and Collaboration:**

1. "The Five Dysfunctions of a Team: A Leadership Fable" by Patrick Lencioni
2. "Crucial Accountability: Tools for Resolving Violated Expectations, Broken Commitments, and Bad Behavior" by Kerry Patterson, Joseph Grenny, Ron McMillan, and Al Switzler
3. "Team of Teams: New Rules of Engagement for a Complex World" by General Stanley McChrystal
4. "Collaborative Intelligence: Thinking with People Who Think Differently" by Dawna Markova and Angie McArthur
5. "The Culture Code: The Secrets of Highly Successful Groups" by Daniel Coyle

- **Leadership Skills:**

1. "Leaders Eat Last: Why Some Teams Pull Together and Others Don't" by Simon Sinek
2. "Emotional Intelligence 2.0" by Travis Bradberry and Jean Greaves
3. "Start with Why: How Great Leaders Inspire Everyone to Take Action" by Simon Sinek
4. "The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change" by Stephen R. Covey
5. "Leadership and Self-Deception: Getting out of the Box" by The Arbinger Institute

- **Problem-Solving and Critical Thinking:**

1. "Critical Thinking: Tools for Taking Charge of Your Learning and Your Life" by Richard Paul and Linda Elder
2. "Think Like a Freak: The Authors of Freakonomics Offer to Retrain Your Brain" by Steven D. Levitt and Stephen J. Dubner
3. "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School" by Idris Mootee
4. "Problem Solving 101: A Simple Book for Smart People" by Ken Watanabe
5. "Mindset: The New Psychology of Success" by Carol S. Dweck

- **Time Management and Organization:**

1. "Getting Things Done: The Art of Stress-Free Productivity" by David Allen
2. "Eat That Frog!: 21 Great Ways to Stop Procrastinating and Get More Done in Less Time" by Brian Tracy
3. "Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones" by James Clear
4. "The Power of Habit: Why We Do What We Do in Life and Business" by Charles Duhigg
5. "Deep Work: Rules for Focused Success in a Distracted World" by Cal Newport

- **Professionalism and Ethics:**

1. "Ethics 101: What Every Leader Needs to Know" by John C. Maxwell
2. "The Power of Ethical Management" by Kenneth Blanchard and Norman Vincent Peale
3. "The Ethical Engineer: An "Ethics Construction Kit" Places Engineering in a New Light" by Robert McGinn
4. "Professionalism: Skills for Workplace Success" by Lydia E. Anderson and Sandra B. Bolt
5. "Business Ethics: Decision-Making for Personal Integrity & Social Responsibility" by Laura P. Hartman and Joseph R. DesJardins.

Spoken Tutorials:

https://spoken-tutorial.org/

https://spoken-tutorial.org/tutorial-search/?search_foss=Communication+Series&search_language=English

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Electromagnetic Wave Engineering	3	0	2	5	7	3	0	1	4
EC201		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	20		20		60			100
		Laboratory	80		-		20			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 to be finalized***	
EC201.1	Understand and apply fundamental concepts of vector calculus and coordinate system transformations to analyze electromagnetic phenomena.
EC201.2	Comprehend and utilize Maxwell's equations, boundary conditions, and basic laws of electromagnetism to solve problems related to electric and magnetic fields.
EC201.3	Analyze and interpret electromagnetic wave propagation phenomena, including wave equations, polarization, power flow, and behaviors in different media.
EC201.4	Apply principles of electromagnetic wave propagation to analyze transmission lines and understand impedance matching techniques.
EC201.5	Utilize numerical methods and computational techniques to analyze and solve practical engineering problems.

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	1	1	2		2					3		
EC201.2	1	1	2		2							
EC201.3	1	1	2		2					3		
EC201.4	1	1	3		2					1		
EC201.5	1	1	3		2					2		3

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
EC201.1						
EC201.2		1				
EC201.3		1				
EC201.4		1				
EC201.5		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	**Coordinate system transformation and vector calculus**		4
	1.1	Cartesian, cylindrical and spherical coordinate, Differential length, area and volume, line surface and volume integrals.	2, 3	
	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	8
	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 Fields and Waves**	1,2	10
	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	**Transmission Lines**	1,2, 3	10
	4.1	Transmission Line parameters and equations governing transmission lines, encompassing resistance, inductance, capacitance, and conductance per unit length, impacting signal propagation.		
	4.2	Input impedance, standing wave ratio (SWR), and power distribution along transmission lines, Smith chart for impedance matching.		
5	Title	**Numerical Methods & Computational Electromagnetics**	2, 4	10

	5.1	Crank-Nicolson method, Gaussian approximating function method, Boundary Element Method (BEM), Runge Kutta method, Modified Euler's method, Finite-Difference Time-Domain (FDTD) method.		
	5.2	Advantages of numerical techniques, Finite difference method (FDM), The Moment Method, Introduction to Finite Element method (FEM), Overview of Applications of Computational Electromagnetics.		
6	**Title**	**Applications of Electromagnetics**		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	
Total				**42**

Sr. No	Title of the Experiment	CO
1	**Gradient, Curl, Divergence & Laplacian:** Implementation of Gradient, Divergence, Curl and Laplacian operation using any simulation tool	**CO1**
2	**Simulation of Transmission line and implement various configurations to understand the concepts related to transmission line.** Using online simulation tool	**CO4**
3	**VSWR Measurement using Microwave workbench**	**CO4**
4	Antenna: Measurement of Radiation Pattern of Antenna	
5	Measurement of EMI/EMC using the equipment.	**CO3**
6	**Virtual Lab:** Introduction to Smith Chart and its application to perform Transmission-line calculations - such as determination of load impedance, reflection coefficient, admittance. Using Virtual Lab IIT Kanpur	**CO4**
7	Single stub matching using transmission lines	**CO4**
8	Microstrip line-based Quarter wave transformer using open source software	**CO4**
9	Solution of one-dimensional boundary value problem using finite difference method	**CO5**
10	Solution of two-dimensional boundary value problem using finite difference method	**CO5**
11	Charge distribution on a thin wire/Capacitance of parallel plate capacitor using Method of Moments	**CO2, CO5**
12	Study the flow of eddy currents in a conductive material subjected to a changing magnetic field using Crank-Nicolson method.	**CO5**
13	Find solution of Electromagnetic Wave Diffraction Problems on Perfectly Conducting Screens using Gaussian approximating function method.	**CO5**

14	Analyze the electromagnetic interference (EMI) produced by electronic devices, such as cables, circuit boards, and electromagnetic shielding using Boundary Element Method (BEM).	**CO5**
15	Solving Maxwell's equations using 4th order Runge Kutta method.	**CO2, CO5**
16	Find approximate voltage across a capacitor in a simple RC circuit at different time points using the Modified Euler's method.	**CO5**
17	Simulating signal propagation and radiation in PCBs and integrated circuit packages using Finite-Difference Time-Domain (FDTD) method.	**CO5**

Text Books :

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
3	Field and Wave Electromagnetics	Second	David Cheng	Addison Wesley	1983
4	Introductory Methods of Numerical Analysis	fifth	S. S. Sastry	PHI Learning Pvt. Ltd.	2024

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	Introduction to Numerical and Analytical Methods with MATLAB® for Engineers and Scientists	First	William Bober	CRC Press	2014
5	Computational Partial Differential Equations Using MATLAB	Second Edition	Jichun Li Yi-Tung Chen	CRC Press	2020

NPTEL Reference: Any of the following lecture series' may be referred by students

1. Lecture series on Transmission Lines and E.M Waves by Prof. R.K.Shevgaonkar, Dept of Electrical Engineering, IIT Bombay https://nptel.ac.in/courses/117101056
2. Lecture series on Electromagnetic Theory by Dr. Pradeep Kumar, IIT Kanpur https://archive.nptel.ac.in/courses/108/104/108104087/
3. Lecture series on Computational Electromagnetics, Prof. Uday Khankhoje, IIT Madras. https://nptel.ac.in/courses/108106152
4. Lecture series on Computational Electromagnetics & Applications, IIT Bombay Prof. Dr. Krish Sankaran https://nptel.ac.in/courses/108101090

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PCC	Electronic Devices & Circuits	3	0	2	4	9	3	0	1	4
EC202		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE (%)		Total
		Theory&		20		20		60		100
		Laboratory		80		-		20		100

Pre-requisite Course Codes, if any.	EC102 Basic Electrical Engineering AS101 Engineering Physics AS106 Tech Shop
Course Objective: To teach fundamentals of electronic devices	
Course Outcomes (CO): ***At the end of the course students will be able to to be finalized***	
EC202.1	Discuss device physics, construction, VI characteristics and applications of semiconductor devices.
EC202.2	Analyze single stage BJT and MOSFET amplifier circuits.
EC202.3	Design single-stage BJT and MOSFET amplifier circuits.
EC202.4	Outline the steps involved in semiconductor device fabrication.
EC202.5	Demonstrate the PCB design and fabrication for the circuit using discrete components.

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	3	1			3				3	1		2
EC202.2	3	1			2				3	1		2
EC202.3	3	1			2				3	1		2
EC202.4	3	3			2				3	1		2
EC202.5	3	1			3				3	3	2	3

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

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
EC202.1	2					
EC202.2	3					

EC202.3	3				3	
EC202.4	2					
EC202.5	3	3			3	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**	**Diode**	1,2	**10**
	1.1	Review of PN Junction Analysis, Piecewise linear model of PN Junction Diode		
	1.2	Applications of Diode: Limiter circuits, Rectifiers, Clamper Circuits, Peak Detector and Voltage Doubler		
	1.3	Zener diode and Schottky diode, Varactor diode, PIN diode, Gunn diode and its applications in communication system		
2	**Title**	**Bipolar and Unipolar Devices**	1,2	**10**
	2.1	**Bipolar Junction Transistor (BJT):** Construction and working of BJT, various BJT configurations such as CE, CB, CC and their VI Characteristics		
	2.2	**Field Effect Device (MOSFET**): Two terminal MOS structure, MOSFET construction, Band diagrams under equilibrium and external bias, Threshold Voltage, V-I and CV characteristics, Channel length modulation, Short Channel effects and various MOSFET configurations such as CG, CD, CS and their VI Characteristics.		
3	**Title**	**DC Biasing of Bipolar and Unipolar Devices**	1,2	**6**
	3.1	Applications of bipolar and unipolar devices as voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier and Switch, Need and requirement of DC Biasing of Bipolar and Unipolar Devices in these applications.		
	3.2	Biasing schemes for BJT and MOSFET as an amplifier, and bias stability.		
	Title	**AC Analysis of Bipolar and Unipolar Devices**		

4	**4.1**	Small signal low frequency and high frequency two port BJT and MOSFET models	1,2	**10**
	4.2	Estimation of voltage gain, input resistance, output resistance, low frequency and high frequency analysis of single stage BJT and MOSFET based amplifiers		
	4.3	Design of single stage BJT and MOSFET based amplifiers for given specifications.		
5	**Title**	**Integrated circuit fabrication process**	R-3	**6**
	5.1	Oxidation, photolithography, chemical vapor deposition, physical vapor deposition, sputtering, diffusion, ion implantation, and Etching.		
	5.2	Fabrication process steps for BJT, and MOSFET and/or any given discrete circuit		
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**

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

Sr. No.	Title of the Experiment
1	To demonstrate any one of the applications of PN junction diode using simulation hardware implementation.
2	To plot characteristics of any one of the special purpose diodes and demonstrate its application using simulation hardware implementation.
3	To plot characteristics of BJT configurations (CE/CB/CC) using simulation and hardware implementation.
4	Verify the stability of the operating point for different biasing circuits.
5	Design and implement single stage BJT based amplifier for the required specifications.
6	Obtain frequency response of single stage BJT based amplifier.
7	To plot characteristics of MOSFET (CG/CS/CD) using Simulation and Hardware Implementation
8	Design and implement single stage MOSFET based amplifier for the required specifications.
9	Obtain frequency response of single stage MOSFET based amplifier.
10	Construct a PCB for any one of the applications based on discrete components.

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

Online Resources: 1. https://archive.nptel.ac.in/courses/108/108/108108122/

2. https://archive.nptel.ac.in/courses/108/102/108102097/

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PCC	Signal, Network and Systems	3	0	2	5	10	3	0	1	4
		Examination Scheme								
EC203		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	

Course Objective: Main objectives of the course are :
1.Describe various signals and systems mathematically and understand how to perform mathematical operations on them,
2. Analysis using Fourier series and Fourier transform for a given signal.
3. Understand network synthesis

Course Outcomes (CO): ***At the end of the course students will be able to***

EC203.1	Classify and illustrate various operations on signals and systems
EC203.2	Analyze the properties of a continuous time signal in frequency domain
EC203.3	Evaluate Linear Time Invariant system response using Laplace Transform
EC203.4	Evaluate Linear Time Invariant system response using Laplace Transform
EC203.5	Analyse RLC circuits in time domain and frequency domain
EC203.6	Design and analyze Butterworth filter

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	2	2	1	2					2		
EC203.2	3	3	2	1	2					2		
EC203.3	3	2	2	1	2					2		
EC203.4	3	3	2	2	2					2		
EC203.5	3	2	2	2	2					2		
EC203.6	3	2	2	1	2					2		

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
EC203.1		2				2
EC203.2		2			2	2
EC203.3		2				2
EC203.4		2				2
EC203.5		2			2	2
EC203.6		2			3	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**	**Continuous Time Signals**	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 nondeterministic, 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	**08**
	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.		
	Title	**Analysis of CT System**		

3	**3.1**	Laplace Transform, Properties of Laplace Transform, Relation between Laplace Transform and Fourier Transform,	1,2	**10**
	3.2	Classification of systems: Static and dynamic, time variant and time invariant, linear, and nonlinear, causal and non-causal, stable and unstable systems.		
	3.3	Impulse Response, Transfer Function, Differential Equation, Stability of Systems, Frequency Response, Solution of Differential Equation using Laplace Transform		
4	**Title**	**Transient Analysis**	3,4	**06**
	4.1	Time domain analysis of R-L-C: Forced and Natural response, time constant, initial, and final values. Effect of damping, Solution using second order equation for standard input signals		
	4.2	Transform domain analysis of R-L-C circuits: Forced and Natural response, Transient and steady state time response.		
5	**Title**	**Network Synthesis**	3,4	**06**
	5.1	**Positive real functions:** Concept of positive real function, testing for Hurwitz polynomials, testing for necessary and sufficient conditions for positive real functions		
	5.2	**Synthesis of RC, RL, LC circuits:** Concepts of synthesis of RC, RL, LC driving point functions.		
6	**Title**	**Filter Design and Realization**	2	**04**
	6.1	Butterworth LPF and HPF design		
	6.2	Realization using Active and passive components		
7	**Self Study**	**State Space Model:** Procedure to determine state equations, State equations from transfer function, Analysis of circuits with and without controlled sources using network theorems, Graph Theory, Two Port Network		**06***
			Total (*Not Included)	**42**

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

Sr. No	Title of the Experiment
1	Operations on Signals
2	Convolution on Continuous Time Signals
3	Synthesis of signals using Fourier Series
4	Synthesis of signals using Fourier Transform
5	Analysis of LTI system using Laplace Transform

6	Response of LTI System for any given input
7	Measure and analyze (settling time, overshoot, undershoot, etc.) step response of for a given series RLC circuit
8	To obtain impulse response and step response of the RC/RL circuit
9	Analyze the given series RLC circuit for standard input signals
10	Frequency response of RLC series circuit
11	Filter Design
12	Active Filter Realization

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Signals and Systems	3rd Edition	Nagoor Kani	Tata McGraw Hill	2011
2	Digital Signal Processing	4th Edition	Ramesh Babu	Scitech	2014
3	Circuit Theory	7th Edition	A. Chakrabarti	Dhanpat Rai and Co., New Delhi	2018
4	Network Analysis	3rd Edition	M E Van Valkenburg	Prentice-Hall of India Pvt. Ltd.	2018

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Signal and Systems	2nd Edition	Alan Oppenheim, Alan Willsky	Pearson	2002
2	Signal and Systems	3rd Edition	Simon Haykin and Barry Van Veen	John Wiley and sons	2002
3	Linear Systems and Signals	4th Edition	B. P. Lathi	Oxford University Press	2005
4	Network Analysis and Synthesis	2nd Edition	Franklin F Kuo	Wiley	2006

NPTEL Courses:

1) Signals and Systems Web Course by Prof. V M Gadre, IIT Bombay
2) Signals and Systems Video Lectures by Prof. K S Venkatesh, IIT Kanpur

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

Semester-IV

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Probability and Stochastic Processes	3	0	0	6	9	3	0	0	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
MA203		Theory	20		20		60			100
		Laboratory	-		--		-			-

Pre-requisite Course Codes, if any.	Linear Algebra, Math's
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 concepts of probability theory to multiple random variables
MA203.4	Investigate significance of Convergence in Random Sequences and application of Central Limit Theorem to engineering problems.
MA203.5	Determine solutions to various characteristics of random processes and investigate the applications to engineering problems.

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										
MA203.2	3	3	2									
MA203.3	3	3	2									
MA203.4	3	3	2									
MA203.5	3	3	3			2						

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA203.1				-		
MA203.2	2				2	
MA203.3	2				2	
MA203.4	2				2	
MA203.5	2			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**	**Probability**	1,2	
	1.1	Sets and set operations; Probability space; Conditional probability and Bayes theorem, Total Probability Theorem		**04**
2	**Title**	**Single Random Variable**	1,2	
	2.1	Discrete random variables, probability mass function, probability distribution function, Standard distributions (discrete).		**08**
	2.2	Continuous random variables, probability density function, probability distribution function, Standard distributions (continuous).		
3	**Title**	**Multiple Random Variables**	1,2	
	3.1	Marginal Probability, Joint PDF, Joint CDF, Conditional probability, Functions of one and two random variables, moments of random variables.		**12**
	3.2	Densities and moments; Characteristic functions of a random variable		
	3.3	Tail Probabilities: Markov, Chebyshev and Chernoff bounds		
4	**Title**	**Sequence of Random Variables**	1,2	
	4.1	Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square)		**06**
	4.2	Limit theorems; Strong and weak laws of large numbers, Central limit theorem.		
5	**Title**	**Random Process**	1,2	
	5.1	**Random processes:** Concept, Classification.		**12**

	5.2	**Random Processes – Temporal Characteristics** Stationarity and Independence; Time Averages; Mean and covariance functions; Ergodicity; Auto-Correlation and Cross-Correlation Functions; Gaussian and Poisson Random Processes; Markov Processes; Complex Random Processes.		
	5.3	**Random Processes – Spectral Characteristics** Power Spectral Density (PSD); Bandwidth; Relation between PSD and Auto/Cross Correlation Functions; Response of LTI System to Random Process		
	5.4	**Practical Applications:** Noise in Amplitude Modulation / Noise in Frequency Modulation / Noise in Phase-Locked Loop.		
6	**Self Study**	**Application of different probability distributions (to any one field of interest but not limited to)** Wireless Communication, Queuing theory, Networking, Digital Signal Processing, VLSI, Finance	1,2	**06***
			Total	**42**

*Not included in the total

Text Books

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, Statistics and Random Processes	3rd	T. Veerarajan	McGraw Hill	2008
2	Probability, Random Variables and Random Signal Principles	4th	Peyton Peebles	Tata McGraw Hill	2009
3	Probability And Random Processes For Electrical Engineering	3rd	Alberto Leon Garcia	Pearson education	2008

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	0	3	2	1	0	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
MA204		Theory	20		20		60			100
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	Basic Engineering Mathematics at first year of Diploma and Foundation of Mathematics-I
Course Objective: To develop basic foundation of mathematical skills.	
Learning Outcomes (LO): ***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	2											
MA204.3	1											
MA204.4	1											
MA204.5	2											
MA204.6	1											

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA204.1						
MA204.2	1					
MA204.3						
MA204.4	1					
MA204.5	2					
MA204.6	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	**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, De Moivre's theorem and its application to determine powers of complex numbers.		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	Forty Fourth	Dr. B. S. Grewal	Khanna Publications	2020

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Engineering Mathematics	Tenth	Erwin Kreysizg	John Wiley & Sons	2011
2	Advanced Engineering Mathematics	Twenty Eighth	H.K.Dass	S.Chand	2014
3	Advanced Engineering Mathematics	Fourth	Jain and Iyengar	Narosa Publications	2014

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PCC	Hardware Description Language (HDL) Programming	1	-	2	5	8	1	-	1	2
		Examination Scheme								
EC204		Component	ISE (%)		MSE (%)		ESE (%)			Total
		Theory	--		--		--			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	CE101: Programming Lab I CE102: Programming Lab II EC101: Digital Systems
Course Objective: The course aims to familiarize students with the syntax, semantics, and constructs of Hardware Description Language (HDL) Programming such as VHDL/Verilog to design, simulate, and verification of digital logic design, including combinational and sequential logic, and finite state machines. Students also learn about synthesis tools, timing constraints, and optimizing designs for area, power, and performance. The course also aims to provide students with insights into industry practices, standards, interfacing of hardware for real life applications and emerging trends in digital hardware and emerging technologies (e.g., hardware accelerators for AI/ML).	

Course Outcomes (CO): ***At the end of the course students will be able to***	
EC204.1	Demonstrate understanding of basic FPGA architecture, FPGA design flow and concepts of CAD tool to write HDL programs.
EC204.2	Understand the basics of HDL, modeling, program structure and basic language elements.
EC204.3	Develop HDL programs for digital systems based on given functional requirements.
EC204.4	Simulate, implement, and validate digital systems using a CAD tool and FPGA.
EC204.5	Interface the external hardware (sensor, actuator, ADC, DAC, LCD, Seven Segment LEDs, etc.) to FPGA through I/O ports.

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	3				3				3			1
EC204.2	3								3			1
EC204.3	3		2						3			1
EC204.4	3	2	3	3	3				3			1
EC204.5	3	2	3	3	3				3			1

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2

EC204.1			1			
EC204.2			1			
EC204.3			1			
EC204.4	1		1		1	
EC204.5	1		1		1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply√	Analyze	Evaluate	Create

Tutorial Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**FPGA Design Flow**	1,2	**3**
	1.1	India Semiconductor Industry and GoI policies.		
	1.2	Introduction to HDL, FPGA Design Flow and EDA tools		
	1.3	FPGA Architecture Fundamentals, and different FPGAs architectures		
2	**Title**	**Fundamentals of VHDL/Verilog**	1,2	**3**
	2.1	HDL program structure and concept of testbench		
	2.2	Language constructs, datatypes, operators etc.		
3	**Title**	**Design abstractions and Modeling Styles**	1,2	**4**
	3.1	Design abstractions, ehavioural, data flow, gate level and switch level modeling		
4	**Title**	**Finite State Machines**	1,2	2
	4.1	HDL programming for both Mealy & Moore FSM		
		Total (*Not included)		**14**

Sr. No.	Suggested List of experiments	Ref.
1	Design, simulate and synthesize any combinational digital design using structural modelling and carry out physical verification on a given FPGA. a.4-bit Ripple Carry Full Adder by instantiating one-bit full adder b.2:1 Mux: Using case Statement	1,2
2	Design, simulate and synthesis any sequential digital design with behavioral modelling and carry out physical verification on a given FPGA. a. D Flip Flop using gates b. S-R Flip Flop	1,2

	b. 8-Bit Up Counter with Load	
3	Design and simulate Round Robin arbiter using behavioral modelling.	1,2
4	Design, simulate and synthesis Pulse-width modulation and carry out physical verification on given FPGA	1,2
5	Design, simulate 4-bit ALU with three logical & three arithmetic operations.	1,2
6	Design, simulate and synthesis Verilog code using FSM for any one of the following: i. Traffic Light controller with 4x4 hex key pad input and display the output in LCD. ii. Elevator operation with 4x4 hex key pad input and display the output in LCD.	1,2
7	Write HDL code to interface ADC/DAC, LCD or 7-segment LED display for any one of the following: i. Accept Analog input signal using ADC from temperature sensor and display the digital output data on LCD or 7-segment LED display. ii. Generate – Sine, Square, Triangle and Ramp waveforms using DAC with different frequency and display the frequency on LCD or 7-segment LED display.	1,2
8	Write HDL code for any one of the communication protocols and display the message on LCD/Seven Segment LEDs. i. Serial ii. I2C Protocol iii. Modbus	1,2
9	Develop a HDL code for implementing algorithms in the areas like machine learning or cryptography using specialized hardware such as SoC for faster processing.	1,2
10	Open-ended problem: Write HDL code for any real-life application and its execution/implementation. i. To control speed, direction of DC motor/Stepper motor and display messages on 16x2 LCD display. ii. To control the temperature of water using Digital PID control algorithm and display the key code on 7-segment LED display.	1,2

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Digital Design and Computer Architecture	1st	David Money Harris, Sarah L. Harris	Elsevier Science	2013
2	VHDL Primer	3rd	Bhasker J	Prentice-Hall of India	2001
3	Verilog HDL: A Guide to Digital Design and Synthesis	2nd	Samir Palnitkar	Pearson Education	2009
4	Advanced Digital Design with Verilog HDL	2nd	Michel D. Ciletti	PHI	2009

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Digital System Design with FPGA: Implementation Using Verilog and VHDL	1st	By Cem Unsalan, Bora Tar	Mc Graw Hill Publication	2017
2	Verilog Hdl Primer	3rd	Bhasker J	BSP	2001
3	Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog	6th	Michel D. Ciletti	Pearson Education	2018

Online Resources:
1. Digital System design with PLDs and FPGAs
Prof. Kuruvilla Varghese, IISc Bangalore
Link: https://nptel.ac.in/courses/117108040
2. Hardware modeling using Verilog,
Prof. Indranil Sengupta, IIT Kharagpur
Link: https://nptel.ac.in/courses/106/105/106105165/

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PCC	Analog and Digital Communication	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
EC205		Theory	20		20		60			100
		Laboratory	80		--		20			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 WiFi 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***

EC205.1	Describe ,Compare , differentiate between various entities of analog, pulse, and digital communication system.
EC205.2	Apply concepts of signals and systems to analyze behavior of modulated signals in time domain, frequency domain and signal space.
EC205.3	Construct various source coding and error correction codes.
EC205.4	Analyze the behavior of a various digital modulation schemes in presence of noise.
EC205.5	Analyze and compute system performance measures such as bit rate and bandwidth of various digital modulation methods, source and error correction codes.

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	3				-				-	-		1
EC205.2	2	2			3				3	3		
EC205.3	2	2			3				3	3		1
EC205.4	3	3			3				3	3		1
EC205.5	2	2			3				3	3		

EC205.1	2	2			3				3	3		1

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

	PEO1	**PEO2**	**PEO3**	**PSO1**	**PSO2**
EC205.1	2	2			
EC205.2	2	2		2	1
EC205.3	2	2		2	1
EC205.4	2	2		2	1
EC205.5	2	2			
EC205.1	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**	**Analog and Pulse modulation**	10	
	1.1	Classification of Frequency spectrum, Need for modulation, Block diagram of an analog and digital communication system.		
	1.2	DSB-FC , DSB-SC : Principle of working, Waveforms and power relations and power spectrum, Single and multitone SSB and FDM FM: Mathematical analysis, Armstrong method of FM generation, Block diagram of Super hetrodyne receiver		
	1.3	Sampling theorem-Proof, Types of Sampling, Pulse Amplitude modulation,PWM,Pulse code modulation (PCM)		
	1.4	Delta modulation, Time Division multiplexing		
2	**Title**	**Source coding and Channel Coding**	08	
	2.1	Uncertainty, Information, Entropy, Source coding theorem, Huffmann encoding, Shannon Fano coding		

	2.2	Channel capacity Theorem, Linear block codes,Cyclic codes-Shift register method and Polynomial division method, Convolutional codes- Shift Register approach, State diagram,Trellis , Viterbi decoding		
3		**Digital Modulation Techniques**	12	
	3.1	Gram-Schmidt Orthogonalization Procedure, Line coding and Power spectral density (PSD) of line codes		
	3.2	BPSK,QPSK,M-PSK,8-QAM,16-QAM,BFSK,M-FSK,MSK-Principle of working, PSD and Signal space analysis.		
4	**Title**	**Baseband Transmission and Optimal Reception of Digital Signal**	06	
	4.1	Inter symbol Interference and Nyquist criterion,Raised cosine filter, Eye diagram,Duobinary encoding and decoding		
	4.2	Probability of error of integrate and dump receiver		
	4.3	Digital Modulation tradeoffs:Probability of Error evaluations of various modulations		
5	**Title**	**Spread Spectrum and OFDM**	06	
	5.1	Direct sequence spread spectrum		
	5.2	Frequency hopping spread spectrum		
	5.3	OFDM		
6	**Self Study**	Applications and health, safety, and environment aspects of Analog and Digital communication techniques		**06**
			Total	**42**

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

Sr. No	**Title of the Experiment**
1	Implementation of double sideband full carrier for various modulation index and demodulation
2	Implement the frequency modulation circuit to obtain FM waveforms and calculate modulation index
3	Implementation of natural sampling and reconstruction of waveforms
4	Implementation of pulse amplitude modulation.
5	LBC encoder and decoder
6	Implementation of Binary Phase Shift Keying

7	Implementation of Binary Frequency shift keying
8	Signal space analysis of QAM
9	PSD and ISI analysis of BPSK
10	BER analysis of BPSK without and with Convolutional codes

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Principles of Communication Systems	2nd	Taub H. and Schilling D.L	Tata McGraw Hill	2001
2	Communications Systems	4th	Haykin S	John Wiley and Sons	2001

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital and Analog Communication	4th	B.P.Lathi	Oxford	2017
2.	Communication Systems Engineering	4th	Proakis J. G. and Salehi M.	Pearson Education	2002.
3.	Digital Communication	3rd	Haykin S	John Wiley and Sons	2001

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PCC	Computer Architecture & Processor Organization	3	0	0	4	7	3	0	0	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
EC206		Theory	20		20		60			100
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	Digital Systems
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*	
EC206.1	Describe basic computer structure with its models and compute performance metrics.
EC206.2	Comprehend processor organization with various design methods of CPU with comparative analysis
EC206.3	Design memory systems with analysis of mapping techniques for cache and virtual memory
EC206.4	Comprehend different types of I/O buses, compare and contrast different types of data transfer methods and arbitration techniques
EC205.5	Analyze different parallel organizations that includes pipelined and parallel processors

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	2										
EC206.3		2	1									
EC206.4	3											
EC206.5		2	1									

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
EC206.1	2						
EC206.2	3	1		2			
EC206.3	3	2	1	3			
EC206.4	2						
EC206.5	2	1		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	**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	1,2	
	1.2	Performance Issues: Designing for performance, Amdahl's Law, Multi-core, GPGPU	1,2	
2	Title	**Processor Organization and Control Unit Design**		10
	2.1	CPU Architecture, Register Organization Instruction formats, basic instruction cycle. Instruction interpretation and sequencing, Case Study of 80386 architecture and Register Organization	2,3	
	2.2	Control Unit: Soft wired (Micro-programmed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations	2,3	
	2.3	RISC and CISC: Introduction to RISC and CISC architectures and design issues.	2,3	
3	Title	**Memory Systems Organization**		12
	3.1	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics.	2	
	3.2	Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory. Case study of Pentium Processor Cache Memory Model (MESI Protocol)	2,4	
	3.3	Virtual Memory: Concept, Segmentation and Paging, Page replacement policies. Case study of 80386 Virtual Memory Concepts	2,3	
4	Title	**I/O Organization**		5
	4.1	Buses: Types of Buses, Bus Arbitration, BUS standards	1,2	
	4.2	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	Title	**Parallel Organization**		11
	5.1	Advanced Processor Models: Real Model, Protected Model, Virtual Model (x86 Processors)	3	
	5.2	Superscalar Architecture: Case study of Pentium processor	4	
	5.3	Pipelined Architecture: Pipleine Stages, Pipeline Hazards, Mitigation of Hazards with branch prediction and data forwarding techniques	1,2,4	

	5.4	Introduction to parallel processing concepts, Flynn's classifications,	2	
6	**Self Study**	Comparative Study of microprocessors and micro architectures with respect to their important features. Detailed analysis of Multicore and GPGPU Architectures. Vector and Array Processors with VLIW architecture. 8086 instruction set with assembler directives		
			Total	**42**

Text Books

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	The 80386, 80486, and Pentium Microprocessor: Hardware, Software, and Interfacing	Third	Walter Triebel	Pearson	1997
4	Pentium Pro Processor System Architecture	Third	Tom Shanely	Addison Wesley	1996

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
4	Advance Computer Architecture: Parallelism, Scalability, Programmability	Third	Kai Hwang	Tata-McGraw Hill	2017

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Mixed Signal Integrated Circuits	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)			Total
EC207		Theory	20		20		60			100
		Laboratory	80		--		20			100

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): ***At the end of the course students will be able to***	
EC207.1	Understand the issues in integration of mixed signal circuits.
EC207.2	Understand feedback topologies, differential amplifier and its analysis.
EC207.3	Identify an op-amp IC to demonstrate its linear/non-linear applications.
EC207.4	Employ ADC / DAC using Integrated Circuits.
EC207.5	Employ a mixed signal IC for a known application.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
EC207.1	2	1										
EC207.2	3	3	3		2							
EC207.3	3	3	3									
EC207.4	3	3	3									
EC207.5	3	3	3	3	3	1		3	3	3	3	3

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

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
EC207.1					1	
EC207.2					1	
EC207.3					1	
EC207.4					1	
EC207.5	1	1		3	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 Mixed Signal and Circuits**	2R	04
	1.1	Analog and digital components within a mixed signal system.		
	1.2	Design principles involved in integrating analog and digital components. Signal processing techniques within mixed signal systems. Noise sources in mixed signal circuits.		
	1.3	Nonlinearity and Mismatch issues in mixed signal integration		
2	Title	**Fundamentals of Operational Amplifier**		10
	2.1	Feedback Topologies, MOSFET Differential Amplifiers. Current Mirrors.	2	
	2.2	Op-Amp functional block diagram, frequency compensation, equivalent circuit.	1,2,3	
	2.3	Specifications of Operational amplifier, Comparison of specifications: uA741/ TLO82/MC3403	1,2,3	
3		**Applications Operational Amplifier**	1,3	12
	3.1	Linear Applications: Inverting and non-inverting amplifier, adder, subtractor, integrator, differentiator, difference amplifier, instrumentation amplifier.		
	3.2	Nonlinear Applications: Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, Schmitt trigger comparator. Sample and Hold Circuit. Precision Rectifiers, Waveform Generators, Peak Detector, Log-Antilog Amplifier.		
	3.3	Active Filters: First order filters, second order active finite and infinite gain low pass, high pass, Notch Filter. Switched Capacitor Filter IC.		
4		**Data Converters**	1,3	08
	4.1	Fundamentals of Data Converters. Nyquist Rate Converters and Oversampling Converters.		
	4.2	Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder. IC DAC 0808		
	4.3	Analog to-digital converters (ADC): Single slope, dual slope,		

		successive approximation, flash. IC ADC 0808.		
5		**Special Purpose Mixed Signal ICs**	1,3	**08**
	5.1	PLL 565, VCO 566 and their applications in telecommunication.		
	5.2	Modem Mixed-Signal IC AD9876 and its applications.		
6	**Self Study**	Emerging trends in mixed signal circuit design. Advanced components and techniques. Case Study: Exploring Mixed Signal Integrated Design.		**06***
*** not included in the total.**			**Total**	**42**

Laboratory Component, if any. (Minimum 8 Laboratory experiments and a case study is expected)

Sr. No.	Title of the Experiment
1	Verify performance of MOSFET Differential amplifier with and without current mirror. (simulation)
2	Verify performance of a circuit based on any one of the feedback topologies. (simulation)
3	To measure and compare (a) Input bias current, (b) Input offset current, (c) Input offset voltage & (d) Slew rate of Op-Amp ICs 741/TLO82/MC3403.
4	Design and implement any one linear application using a suitable Op-Amp IC.
5	Design and implement any one non-linear application using a suitable Op-Amp IC.
6	Design and implement an active filter circuit using a suitable IC.
7	Design and implement any one ADC/DAC circuit using ADC 0808.
8	Design an application using any one special purpose IC.
9	Construct a PCB for any one of the applications based on Mixed signal IC.

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Op-Amps and Linear Integrated Circuits	Fourth	Ramakant A. Gayakwad	Pearson Prentice Hall	2015
2	Electronic Circuit Analysis and Design	Third	Donald A. Neamen	Tata McGraw Hill	2006
3	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
1R	Analog/RF and Mixed Signal Circuit Systematic Design.	First	Mourad Fakhfakh, Esteban Tlelo Cuautle, Rafael Castro Lopez.	Springer	2013.
2R	Mixed-Signal Circuits (Devices)	First	Thomas_Noulis_	CRC Press	2021