COURSE HAND-OUT

B.TECH. - SEMESTER III

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING (EC), RSET

VISION

TO EVOLVE INTO A CENTRE OF EXCELLENCE IN ELECTRONICS AND COMMUNICATION ENGINEERING, MOULDING PROFESSIONALS HAVING INQUISITIVE, INNOVATIVE AND CREATIVE MINDS WITH SOUND PRACTICAL SKILLS WHO CAN STRIVE FOR THE BETTERMENT OF MANKIND

MISSION

TO IMPART STATE-OF-THE-ART KNOWLEDGE TO STUDENTS IN ELECTRONICS AND COMMUNICATION ENGINEERING AND TO INCULCATE IN THEM A HIGH DEGREE OF SOCIAL CONSCIOUSNESS AND A SENSE OF HUMAN VALUES, THEREBY ENABLING THEM TO FACE CHALLENGES WITH COURAGE AND CONVICTION

B.TECH PROGRAMME

Program Outcomes (POs)

Engineering students will be able to

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

member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life -long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

Program-Specific Outcomes (PSOs)

Engineering students will be able to:

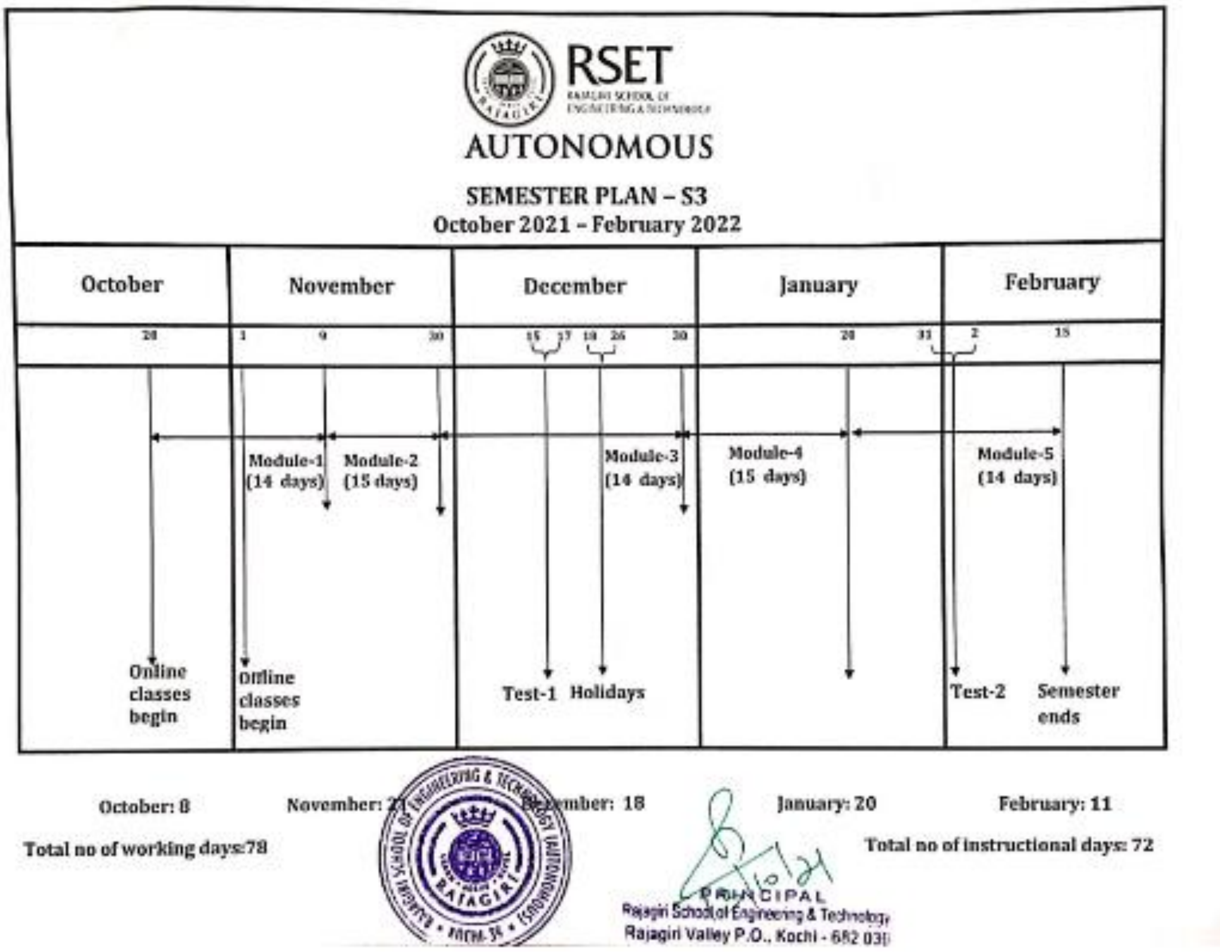
1. Demonstrate their skills in designing, implementing and testing analogue and digital electronic circuits, including microprocessor systems, for signal processing, communication, networking, VLSI and embedded systems applications;

2. Apply their knowledge and skills to conduct experiments and develop applications using electronic design automation (EDA) tools;

3. Demonstrate a sense of professional ethics, recognize the importance of continued learning, and be able to carry out their professional and entrepreneurial responsibilities in electronics engineering field giving due consideration to environment protection and sustainability.

INDEX

1. SEMESTER PLAN



2. SCHEME

SLOT	Code	Subject	Hours/Week			Credits
			L	T	P	
A	100905/MA300A	PARTIAL DIFFERENTIAL EQUATION AND COMPLEX ANALYSIS	3	1	0	4
B	100001/EC300B	SOLID STATE DEVICES	3	1	0	4
C	100001/EC300C	LOGIC CIRCUIT DESIGN	3	1	0	4
D	100001/EC300D	NETWORK THEORY	3	1	0	4
E	100908/EC900E	PROFESSIONAL ETHICS	2	0	0	2
F	100908/CO300F	SUSTAINABLE ENGINEERING	2	0	0	-
S	100001/EC322S	SCIENTIFIC COMPUTING LAB	0	0	3	2
T	100001/EC322T	LOGIC DESIGN LAB	0	0	3	2

100905/MA300A

PARTIAL DIFFERENTIAL EQUATION AND COMPLEX ANALYSIS

COURSE INFORMATION SHEET

PROGRAMME: COMMON EXCEPT CS/IT	DEGREE: BTECH
PROGRAMME: EC	DEGREE: **B. TECH** UNIVERSITY**: A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
COURSE: PARTIAL DIFFERENTIAL EQUATIONSAND COMPLEX ANALYSIS	SEMESTER**: III** CREDITS: **4**
COURSE CODE: 100905_MA300A REGULATION: UG	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: ENGINEERING MATHEMATICS	CONTACT HOURS: **3+1 (Tutorial) hours/Week.**

SYLLABUS:

UNIT	DETAILS	HOURS
I	**PARTIAL DIFFERENTIAL EQUATIONS** Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order- Lagrange'slinearequation,Non-linearequationsofthefirstorder-Charpit'smethod,Solution of equation by method of separation ofvariables.	8
II	**APPLICATION OF PARTIAL DIFFERENTIAL EQUATIONS** One dimensional wave equation- vibrations of a stretched string, derivation, solution of the wave equation using method of separation of variables, D'Alembert's solution of the wave equation, One dimensional heat equation, derivation, solution of the heat equation	10
III	**COMPLEX VARIABLE-DIFFERENTIATION** Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations,harmonicfunctions,findingharmonicconjugate,Conformalmappings-mappings **.**$w = z^2$, , $w = e^z$,. Linear fractional transformation w =1/z. fixed points, Transformation w=z sin z(From sections 17.1, 17.2 and 17.4 only mappings $w = z^2$, , w	9

	$= e^z$, $w = 1$, $w = sinz$ and problems based on these transformation need to be discussed.	
IV	**COMPLEX VARIABLE-INTEGRATION** Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method-indefinite integration and substitution of limit, second evaluation method-use of a representationofapath,Contourintegrals,Cauchyintegraltheorem (withoutproof)onsimply connected domain, Cauchy integral theorem (without proof) on multiply connected domain CauchyIntegralformula(withoutproof),CauchyIntegralformulaf orderivativesofananalytic function, Taylor's series and Maclaurin series.,	9
V	**COMPLEX VARIABLE-RESIDUE INTEGRATION** Laurent's series(without proof), zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem. Resudue integration of real integrals and rational functions. Improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$.	9
TOTAL HOURS		**45**

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T1	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44thEdition,2018.
T2	Erin Kreyszig: Advanced Engineering Mathematics, 10th edition, Wiley
R1	Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 201

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
	A basic course in partial differentiation and complex numbers	To develop basic ideas on partial differentiation and Complex numbers etc.	

COURSE OBJECTIVES:

1	To equip the students with methods of solving partial diff. equation with first order
2	To familiarize them with the concept of boundary value problems which have many applications in engineering like heat and wave equations
3	To understand the basic theory of functions of a complex variable, calculus of complex valued functions and conformal transformations

COURSE OUTCOMES:

SNO	DESCRIPTION	Bloom's Taxonomy Level
CO 1	**Identify the** concept and the solution of partial differential equation.	Remember (Level 1)
CO 2	**Analyze** and solve one dimensional wave equation and heat equation.	Analyse (Level 4)
CO 3	**Understand** complex functions, its continuity differentiability with the use of Cauchy-Riemann equations.	Understand (Level 2)
CO 4	**Evaluate** complex integrals using Cauchy's integral theorem and Cauchy's integralformula, understand the series expansion of analytic function	Evaluate (Level 5)
CO 5	Understand the series expansion of complex function about a singularity and **apply** residue theorem to compute several kinds of real integrals.	Apply (Level 3)

CO-PO AND CO-PSO MAPPING

	PO1														
CO 1	3														
CO 2	3														
CO 3	3														
CO 4	3														
CO 5	3														

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
CO 1-PO 1	3	Fundamental knowledge in PDE will help to analyse the Engineering problems very easily
CO 1-PO 2	3	Basic knowledge for the solution of PDE will help to model various problems in engineering fields
CO 1-PO 3	3	Solution of PDE will help to simplify problems with high complexity in Engineering
CO 1-PO 4	3	Non-linear partial differential equations will help to design solutions to various complex engineering problems
CO 1-PO 5	2	Find the difference between complete integral and singular integral of a partial differentialequation
CO 1-PO 6	1	Variable separable form will help to enrich the analysis of engineering problem
CO 1-PO 10	2	Analyse the method of separation of variables for solving PDE
CO 1-PO 12	2	Methods for the solutions of PDE will give a thorough knowledge in the application problem
CO 2-PO 1	3	Will able to analyse various methods of solutions of boundary value problems
CO 2-PO 2	3	Will able to analyse various methods of solutions of initial value problems
CO 2-PO 3	3	Analyse one dimensional wave equation
CO 2-PO 4	3	Analyse one dimensional heat equation
CO 2-PO 5	2	Analyse D-Alembert’s solution of wave equation
CO 2-PO 6	1	Analyse Fourier solution of heat equation
CO 2-PO 10	2	Apply the concept of above in boundary application
CO 2-PO 12	2	Apply the concept in the solution of heat equation
CO 3-PO 1	3	Understand the idea of complex variable and functions
CO 3-PO 2	3	Understand the idea of continuity of complex valued functions

CO 3-PO 3	3	Understand the idea of differentiability of complex valued function
CO 3-PO 4	3	Understand the concept of Differentiability and Cauchy Riemann equations
CO 3-PO 5	2	Understand the engineering application of analytic function in fluid mechanics
CO 3-PO 6	1	Understand the idea about stream and potential function
CO 3-PO 10	2	Understand the idea about harmonic function
CO 3-PO 12	2	Understand the idea about harmonic conjugate
CO 4-PO 1	3	Evaluation Cauchy's integral theorem
CO 4-PO 2	3	Evaluation of complex integration
CO 4-PO 3	3	Evaluation of Cauchy's integral formula
CO 4-PO 4	3	Evaluation of complex integral using Cauchy's integral formula
CO 4-PO 5	2	Understanding of the idea of complex integration
CO 4-PO 6	1	Understanding of idea about multi connected region
CO 4-PO 10	2	Series expansion of analytic function
CO 4-PO 12	2	Understand the significance of series expansion in practical problems
CO 5-PO 1	3	Knowledge about the singularities
CO 5-PO 2	3	Understanding of residues and its evaluation
CO 5-PO 3	3	Apply the residue theorem for evaluation of real integrals
CO 5-PO 4	3	Apply the residue theorem for evaluation of integrals
CO 5-PO 5	2	Derivation of residue theorem
CO 5-PO 6	1	Analyse the application of residue theorem
CO 5-PO 10	2	Apply the residue theorem for evaluation of improper integrals
CO 4-PO 12	2	Apply the residue theorem for evaluation of trigonometric functions

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
CO1 – PSO 1	3	Partial differential equations can be used to model problems in electrical equivalent circuit.
CO2 - PSO 1	3	Solving problems in thermal engineering requires a working knowledge of the heat equation and methods of solution
CO3 - PSO 1	3	Solutions of the Laplace equation, and harmonic conjugates have applications in electromagnetic and communication engineering.
CO1 - PSO 2	2	The various methods for solving partial differential equations can be used to analyse communication systems

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS:

SNO	DESCRIPTION	RELEVENCE TO PO	PROPOSED ACTIONS
1	Basic concepts on complex analysis	1	Reading, Assignments
2	Application of complex analysis in solving various Engineering problems	2 & 3	Reading
3	Solution of Homogenous PDE with constant Coefficient	2	Reading

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SINO:	**TOPIC**	**PROPOSED ACTIONS**	**RELEVENCE TO PO**

1	Application of analytic functions in Engineering	Reading	3
2	Derivation of Cauchy’s integral theorem and Residue theorem	Reading	1
3	Application of Residue theorem in the evaluation of real integrals	Reading	2
4	Steady state condition of one dimensional heat equation	Reading	3

WEB SOURCE REFERENCES / ICT ENABLED TEACHING LEARNING RESOURCES:

	http://www.math.com/

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ STUD. ASSIGNMENT	☑ WEB RESOURCES	☑LCD/SMART BOARDS
☐ STUD. SEMINARS	☐ ADD-ON COURSES		

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☐ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by
Anisha Anilkumar

Approved by
Dr. Ramkumar P.B.
(HOD)

COURSE PLAN

UNIT	DETAILS	HOURS
I	**PARTIAL DIFFERENTIAL EQUATIONS** Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order-Lagrange'slinearequation,Non-linearequationsofthefirstorder-Charpit'smethod,Solution of equation by method of separation ofvariables.	8
II	**APPLICATION OF PARTIAL DIFFERENTIAL EQUATIONS** One dimensional wave equation- vibrations of a stretched string, derivation, solution of the wave equation using method of separation of variables, D'Alembert's solution of the wave equation, One dimensional heat equation, derivation, solution of the heat equation	10
III	**COMPLEX VARIABLE-DIFFERENTIATION** Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations,harmonicfunctions,findingharmonicconjugate,Conformalmappings-mappings .$w = z^2$, , $w = e^z$,. Linear fractional transformation w =1/z. fixed points, Transformation w=z sin z(From sections 17.1, 17.2 and 17.4 only mappings $w = z^2$, , $w = e^z$, $w = 1$, $w = sinz$ and problems based on these transformation need to be discussed.	9
IV	**COMPLEX VARIABLE-INTEGRATION** Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method-indefinite integration and substitution of limit, second evaluation method-use of a representationofapath,Contourintegrals,Cauchyintegraltheorem(withoutproof)onsimply connected domain, Cauchy integral theorem (without proof) on multiply connected domain CauchyIntegralformula(withoutproof),CauchyIntegralformulaforderivativesofananalytic function, Taylor's series and Maclaurin series.,	9
V	**COMPLEX VARIABLE-RESIDUE INTEGRATION** Laurent's series(without proof), zeros of analytic functions, singularities, poles, removable singularities,	9

	essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem. Resudue integration of real integrals and rational functions. Improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$.	
TOTAL HOURS		**45**

QUESTION BANK

Module 1

- Form the differential equation satisfied by $xyz = \varphi(x + y + z)$.
- Form the differential equation satisfied by $z = f(x) + e^y g(x)$.
- Form the differential equation satisfied by $z = f_1(y + 2x) + f_2(y - 3x)$.
- Solve the PDE $xp + yq = 3z$
- Solve the PDE $(y^2 + z^2 - x^2)p - 2xyq + 2xz = 0$
- Solve the PDE $z(x + y)p + z(x - y)q = x^2 + y^2$ (Hint: $(x, -y, z)$ and $(y, x, -z)$ are the multipliers)
- Solve the PDE $q = px + p^2$ by Charpit's method
- Using Charpit's method solve $p^2x + q^2y = z$
- Using Charpit's method solve $pxy + pq + qy = yz$
- Using Charpit's method solve $1 + p^2 = qz$

Module 2

1. Derive the one dimensional wave equation.
2. Find the solution of the wave equation corresponding to the initial deflection
$$f(x) = \begin{cases} \frac{2k}{l}x & 0 < x < l/2 \\ \frac{2k}{l}(l - x) & l/2 < x < l \end{cases}$$
and initial velocity 0.
3. A tightly stretched string of length l has its ends fastened at $x = 0, x = l$. The mid point of the string is then taken to a height h and the string is then released from rest in that position. Find the lateral displacement of a point of the string at time t from the instant of release.
4. Solve $\frac{\partial^2 y}{\partial t^2} = 4\frac{\partial^2 y}{\partial x^2}$ using the method of separation of variables subject to
$$y(0, t) = y(5, t) = 0$$
$$y(x, 0) = 0, \frac{\partial y}{\partial t} = \begin{cases} 0 & 0 \le x < 4 \\ 5 - x & 4 \le x \le 5 \end{cases}$$
5. Solve $\frac{\partial^2 y}{\partial t^2} = 8\frac{\partial^2 y}{\partial x^2}$ using the method of separation of variables subject to
$$y(0, t) = y(2\pi, t) = 0$$
$$y(x, 0) = \begin{cases} 3x & 0 \le x \le \pi \\ 6\pi - 3x & \pi < x \le 2\pi \end{cases}, \frac{\partial y}{\partial t} = 0$$

Module 3

1. Show that $\lim_{z\to 0} \dfrac{x^2y}{x^4+y^2}$ does not exist even though this function approaches the same limit along every straight line through the origin.
2. Find out, and give reason, whether
$$f(z) = \begin{cases} (Re\, z^2)/|z| & z \neq 0 \\ 0 & z = 0 \end{cases}$$
is continuous at $z = 0$.
3. Show that $w = \sin z$ is analytic everywhere. Also find its derivative.
4. Show that
$$f(z) = \begin{cases} \dfrac{x^3(1+i) - y^3(1-i)}{x^2+y^2} & z \neq 0 \\ 0 & z = 0 \end{cases}$$
satisfies the Cauchy-Riemann equations at $z = 0$, but not differentiable at $z = 0$.
5. Find the value of a so that $u = xy + ax^2 - y^2$ is harmonic. Find its harmonic conjugate.
6. Find the harmonic conjugate of $u = \dfrac{x}{x^2+y^2}$
7. Find the critical point and fixed point of $w = \dfrac{1}{2}\left(z + \dfrac{1}{z}\right)$
8. Discuss the transformation $w = cos\ z$

Module 4

1. Find the Maclaurin series of $\sin^2(z)$ and its radius of convergence.
2. Find the Taylor series of $f(z) = \cos z$ with center at $z_0 = \pi$, and find its radius of convergence.
3. Find the Taylor series of $f(z) = \dfrac{1}{(z-i)^2}$ with center at $z_0 = -i$, and find its radius of convergence.
4. Evaluate $\int_C e^z dz$, where C is the shortest path from $\dfrac{\pi}{2i}$ to $\pi i i$.
5. Evaluate $\int_C z e^{z^2} dz$, where C is the path from 1 along the axes to i.
6. Evaluate $\int_C Re(z^2) dz$ clockwise around the boundary of the square with vertices $0, i, 1+i, 1$.
7. Show that $\int_C \dfrac{1}{z} dz = \pi i$ or $-\pi i$ according as C is the semicircle $|z| = 1$ above or below the real axis from $(1, 0)$ to $(-1, 0)$.
8. Evaluate $\int_C \dfrac{cos\pi z}{z^2-1} dz$ where C is the rectangle with vertices $2 \pm i,\ -2 \pm i$
9. Evaluate $\int_C \dfrac{e^z}{(z+1)^3} dz$ where C is $|z+1| = 1$
10. Evaluate $\int_C \dfrac{z^2+5z+3}{(z-2)^3} dz$ where C is $|z| = 3$

Module 5

1. Find the Laurent series expnasion of $\dfrac{1}{z^2(z-i)}$ at the singular point $z = i$.

2. Find the Laurent series expnasion of $z^3\ cosh\dfrac{1}{z}$ at the singular point $z = 0$.

3. Determine singularities of the following function

   (a) $tan\ \pi z$

   (b) $cot\ z$

   (c) $\dfrac{1}{1-e^z}$

4. Expand the following function in Laurent's series

   (a) $\dfrac{1}{z-2},\ for\ |z| > 2$

   (b) $\dfrac{z^2-1}{(z+2)(z+3)}\ for\ |z| > 3$

5. Find the Laurent series expansion of $\dfrac{1-cos\ z}{z^3}$, about $z = 0$.

6. Find all singular points and the corresponding residues:

   (a) $\dfrac{1}{(z^2-1)^2}$

   (b) $\dfrac{1/3}{z^4-1}$

   (c) $\dfrac{z^2}{z^4-1}$

100001/EC300B

SOLID STATE DEVICES

COURSE INFORMATION SHEET

PROGRAMME: ELECTRONICS & COMMUNICATION ENGINEERING	DEGREE: B. TECH
COURSE: SOLID STATE DEVICES	SEMESTER: 3 CREDITS: 4
COURSE CODE: 100902/EC300B REGULATION: 2021	COURSE TYPE: CORE
COURSE AREA/DOMAIN: ELECTRONICS	CONTACT HOURS: 3 +1 (Tutorial) Hours/Week
CORRESPONDING LAB COURSE CODE (IF ANY): Nil	LAB COURSE NAME: Nil

SYLLABUS:

Module 1:

Elemental and compound semiconductors, Intrinsic and Extrinsic semiconductors, concept of effective mass, Fermions-Fermi Dirac distribution, Fermi level, Doping & Energy band diagram, Equilibrium and steady state conditions, Density of states & Effective density of states, Equilibrium concentration of electrons and holes.

Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi-Fermi levels.

Module 2:

Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect.

Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi-Fermi level.

Module 3:

PN junctions: Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation.

Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics.

Bipolar junction transistor, current components, Transistor action, Base width modulation.

Module 4:

Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, threshold voltage, body effect, MOSFET-structure, types, drain current equation (derive)-linear and saturation region, Drain characteristics, transfer characteristics.

Module 5: Two port network Parameters

MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling.

Sub threshold conduction in MOS.

Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects.

Non-Planar MOSFETs: Fin FET –Structure, operation, and advantages.

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T1	Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson 6/e, 2010 (Modules I, II and III)
T2	Sung Mo Kang, CMOS Digital Integrated Circuits: Analysis and Design, McGraw-Hill, Third Ed., 2002 (Modules IV and V)

R1	Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012
R2	Sze S.M., Semiconductor Devices: Physics and Technology, John Wiley, 3/e, 2005
R3	Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
R4	Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005
R5	Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill,2015
R6	Yannis Tsividis, Operation and Modelling of the MOS Transistor, Oxford University press
R7	Jan M.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits – A Design Perspective, PHI.

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME
100908/MA100A	LINEAR ALGEBRA AND CALCULUS
100906/PH900B	ENGINEERING PHYSICS

COURSE OBJECTIVES:

1	To provide an insight into the basic semiconductor concepts.
2	To provide a sound understanding of current semiconductor devices and technology to appreciate its applications to electronics circuits and system

COURSE OUTCOMES:

Sl. No	**DESCRIPTION**	**Blooms' Taxonomy Level**
1	Graduates will be able to **define** and **understand** the concepts in semiconductor physics.	Knowledge & Understand (Level 1, 2)
2	Graduates will be able to **describe** and **apply** the generation and recombination processes in semiconductors.	Understand & Apply (Level 2, 3)
3	Graduates will be able to **explain** the structure, creation of electric field and working of PN junction semiconductor diodes.	Understand (level 2)
4	Graduates will be able to **illustrate** the minority carrier distribution across PN junction semiconductor diodes.	Apply (level 3)
5	Graduates will **develop** skills and can-do research in new concepts and devices.	Create (level 6)
6	Graduates can **summarize** concepts that studied relating different modes of operation and the various current components in BJTs and **analyze** energy band diagram of PN junction diodes, BJTs, metal semiconductor junctions and MOS capacitors.	Evaluate & Analyze (level 5,4)

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2										3	2	3	
2	2	2		1											
3	2	2		1											

4	2	2		1											
5	2	2		3								2			
6	2	2		1											
100902/ EC300B	2.2	2		1.4								2.5	2	3	

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
PO1-CO.1	3	Application of fundamental knowledge in semiconductor physics
PO1-CO.2,3,4,5,6	2	Application of basic knowledge to complex engineering problems
PO2-CO.1,2,3,4,5,6	2	Identification and analysis of complex engineering problems
PO4-CO.2,3,4,6	1	Analysis and produce valid conclusions
PO4-CO.5	3	Develop new skills and to produce valid conclusions
PO12-CO1	3	Understanding of semiconductor physics will help them in lifelong learning
PO12-CO5	2	Research in new concepts helps them in independent learning
PSO1-CO.1	2	Knowledge in semiconductor physics will help them in VLSI systems
PSO2-CO.1	3	Knowledge in semiconductor physics will help them in developing applications using EDA tools

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No	DESCRIPTION	PROPOSED ACTIONS
1	Fabrication of PN Junctions, FETs etc.	NPTEL + Reading Assignments
2	Physics of HEMT devices	NPTEL + Reading Assignments

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

Sl. No	DESCRIPTION	PROPOSED ACTIONS
1	Heterojunction FET	Web reference [3]
2	Device Fabrication	Web reference [1,2]
3	SPICE models	Web reference [2,4]

WEB SOURCE REFERENCES:

1	NPTEL, IITM: Solid State Devices
2	NPTEL web content IITD: Semiconductor Devices
3	PURDUE UNIVERSITY: Modern MOSFET
4	JLab Science education: The element SI

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☐ CHALK & TALK	☐ STUD. ASSIGNMENT	☐ ONLINE PLATFORM	☐ WEB RESOURCES
☐ LCD/SMART BOARDS	☐STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS	☐STUD. SEMINARS	☐ STUD. VIVA	☐ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ TESTS/MODEL EXAMS	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY
☐ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by
Dr. Simi Zerene Sleeba
Ms. Jasmin Sebastin
Mr. Kiran K A

Approved by
Dr. Rithu James
(HoD)

COURSE PLAN

No	Topic	No. of Lectures
1	**Module1**	
1.1	Elemental and compound semiconductors, Intrinsic and Extrinsic semiconductors, Effective mass	2
1.2	Fermions-Fermi Dirac distribution, Fermi level, Doping & Energy band diagram	2
1.3	Equilibrium and steady state conditions, Density of states & Effective density of states	1
1.4	Equilibrium concentration of electrons and holes.	1
1.5	Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels.	2
1.6	TUTORIAL	**2**
2	**Module 2**	
2.1	Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping.	2
2.2	Diffusion equation	1
2.3	Einstein relations, Poisson equations	1
2.4	Continuity equations, Current flow equations	1
2.5	Diffusion length, Gradient of quasi Fermi level	1
2.6	TUTORIAL	2
3	**Module 3**	
3.1	PN junctions : Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams	2
3.2	Ideal diode equation	1
3.3	Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics	3
3.4	Bipolar junction transistor – working,, current components, Transistor action, Base width modulation.	2
3.5	Derivation of terminal currents in BJT	2
3.6	TUTORIAL	1
4	**Module 4**	
4.1	Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion	2
4.2	Threshold voltage, body effect	1

4.3	MOSFET-structure, working, types,	2
4.4	Drain current equation (derive)- linear and saturation region, Drain characteristics, transfer characteristics.	2
4.5	TUTORIAL	1
5	**Module 5**	
5.1	MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling.	2
5.2	Sub threshold conduction in MOS.	1
5.3	Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects.	3
5.4	Non-Planar MOSFETs: Fin FET –Structure, operation and advantages	1

MODEL QUESTION PAPER

RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)
THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

100902/EC300B SOLID STATE DEVICES

Max. Marks: 100 Duration: 3 Hours

PART A
(Answer ALL Questions. Each Carries 3 mark.)

1. Draw the energy band diagram of P type and N type semiconductor materials, clearly indicating the different energy levels.
2. Indirect recombination is a slow process. Justify
3. Explain how mobility of carriers vary with temperature.
4. Show that diffusion length is the average length a carrier moves before recombination.
5. Derive the expression for contact potential in a PN junction diode.
6. Explain Early effect? Mention its effect on terminal currents of a BJT.
7. Derive the expression for threshold voltage of a MOSFET.
8. Explain the transfer characteristics of a MOSFET in linear and saturation regions.
9. Explain Subthreshold conduction in a MOSFET. Write the expression for Subthreshold current.
10. Differentiate between constant voltage scaling and constant field scaling.

PART – B
(Answer one question from each module; each question carries 14 marks.)

Module – I

1.(a) Derive law of mass action. (8 marks)

(b) An n-type Si sample with $N_d = 10^5$ cm^{-3} is steadily illuminated such that $g_{op} = 10^{21}$ EHP/cm^3 s. If $\tau n = \tau p = 1\mu s$ for this excitation, Calculate the separation in the Quasi-Fermi levels (Fn-Fp). Draw the Energy band diagram. (6 marks)

OR

2. (a) Draw and explain Fermi Dirac Distribution function and position of Fermi level in intrinsic and extrinsic semiconductors. (8 marks)

(b) The Fermi level in a Silicon sample at 300 K is located at 0.3 eV below the bottom of

the conduction band. The effective densities of states N_c= 3.22 X 10^{19} cm^{-3} and N_v=1.83 x 10^{19} cm^{-3}. Determine (a) the electron and hole concentrations at 300K (b) the intrinsic carrier concentration at 400 K.
(6 marks)

Module – II

3. (a) Derive the expression for mobility, conductivity and Drift current density in a semiconductor. (8 marks)
(b) A Si bar 0.1 μm long and 100 $μm^2$ in cross-sectional area is doped with 10^{17} cm^{-3} phosphorus. Find the current at 300 K with 10 V applied. How long will it take an average electron to drift 1 μm in pure Si at an electric field of 100 V/cm? (6 marks)

OR

4. (a) A GaAs sample is doped so that the electron and hole drift current densities are equal in an applied electric field. Calculate the equilibrium concentration of electron and hole, the net doping and the sample resistivity at 300 K. Given μn = 8500 cm^2/Vs, μp = 400 cm^2/Vs, ni = 1.79 x 10^6 cm^{-3}.
(7 marks)
(b) Derive the steady-state diffusion equations in semiconductors. (6 marks)

Module - III

5.(a) Derive the expression for ideal diode equation. State the assumptions used. (9 marks)

(b) Boron is implanted into an n-type Si sample (Nd = $10^{16}cm^{-3}$), forming an abrupt junction of square cross section with area = 2 x 10^{-3} cm^2 . Assume that the acceptor concentration in the p-type region is Na = 4 x 10^{18} cm^{-3} . Calculate V_0 , W, Q_+, and E_0 for this junction at equilibrium (300 K).
(5 marks)

OR

6.With the aid of energy band diagrams, explain how a metal – N type Schottky contact function as rectifying and ohmic contacts. (14 marks)

Module - IV

7. (a) Starting from the fundamentals, derive the expression for drain current of a MOSFET in the two regions of operation. (8 Marks)

(b) Find the maximum depletion width, minimum capacitance C_i, and threshold voltage for an ideal MOS capacitor with a 10-nm gate oxide ($Si0_2$) on p-type Si with Na = 10^{16} cm-3. (b) Include the effects of flat band voltage, assuming an n + polysilicon gate and fixed oxide charge of 5 x 10^{10} q (C/cm^2). (6 marks)

OR

8. (a) Explain the CV characteristics of an ideal MOS capacitor (8 Marks)

(b) For a long channel n-MOSFET with W = 1V, calculate the V_G required for an $I_{D(sat.)}$ of 0.1 mA and $V_{D(sat.)}$ of 5V. Calculate the small-signal output conductance g and V and the transconductance $g_{m(sat.)}$ at V_D = 10V. Recalculate the new I_D for (V_G - V_T) = 3 and V_D = 4V.
(6 marks)

Module - V

9. Explain Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects associated with scaling down of MOSFETs
(14 marks)

OR

10. With the aid of suitable diagrams explain the structure and working of a FINFET. List its advantages.
(14 marks)

100001/EC300C

LOGIC CIRCUIT DESIGN

COURSE INFORMATION SHEET

PROGRAMME: Electronics and Communication Engineering	DEGREE: B.Tech
COURSE: LOGIC CIRCUIT DESIGN	SEMESTER: 3 CREDITS: 4
COURSE CODE 100902/EC300C REGULATION: 2021	COURSE TYPE: CORE
COURSE AREA/DOMAIN: DIGITAL ELECTRONICS	CONTACT HOURS: 4 hours /Week.
CORRESPONDING LAB COURSE CODE (IF ANY): 100902/EC322T	LAB COURSE NAME: LOGIC DESIGN LAB

SYLLABUS:

UNIT	DETAILS	HOURS
I	Binary and hexadecimal number systems; Methods of base conversions; Binary and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary coded decimal codes; Gray codes; Excess 3 code. Alphanumeric codes: ASCII. Basics of verilog -- basic language elements: identifiers, data objects, scalar data types, operators.	12
II	Boolean postulates and laws – Logic Functions and Gates De-Morgan's Theorems, Principle of Duality, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map Minimization. Modeling in verilog, Implementation of gates with simple verilog codes.	7
III	Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel	8

	Adders, BCD Adder. Modeling and simulation of combinatorial circuits with verilog codes at the gate level	
IV	Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Conversion of Flipflops, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters and implementation in verilog, Shift registers-SIPO, SISO, PISO, PIPO. Shift Registers with parallel Load/Shift, Ring counter and Johnsons counter. Asynchronous and Synchronous counter design, Mod N counter. Modeling and simulation of flipflops and counters in verilog.	11
V	TTL, ECL, CMOS - Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product. TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS.	7
TOTAL HOURS		45

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1.	Mano M.M., Ciletti M.D., “Digital Design”, Pearson India, 4th Edition. 2006
2.	D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1989
3.	S. Brown, Z. Vranesic, “Fundamentals of Digital Logic with Verilog Design”, McGraw Hill
4.	Samir Palnikar“Verilog HDL: A Guide to Digital Design and Syntheis”, Sunsoft Press

5.	R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009
6.	W.H. Gothmann, "Digital Electronics – An introduction to theory and practice", PHI, 2nd edition ,2006
7.	Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008
8.	A. Ananthakumar ,"Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016
9	Fletcher, William I., An Engineering Approach to Digital Design, 1st Edition, Prentice Hall India, 1980

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
100908/CO900F	Basic Electrical and Electronics Engineering		2nd

COURSE OBJECTIVES:

1	Impart the basic knowledge of logic circuits and enable students to apply it to design a digital system.

COURSE OUTCOMES:

SNO	DESCRIPTION
1	Explain the elements of digital system abstractions such as digital representations of information, digital logic and Boolean algebra
2	Create an implementation of a combinational logic function described by a truth table using and/or/inv gates/ muxes
3	Compare different types of logic families with respect to performance and efficiency
4	Design a sequential logic circuit using the basic building blocks like flip-flops
5	Design and analyze combinational and sequential logic circuits through gate level Verilog models.

CO-PO-PSO MAPPING:

	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3											3		
2	3	3	3										3		
3	3	3											3		
4	3	3	3										3		
5	3	3	3		3									3	
100902/EC300C	**3**	**3**	**3**		**3**										

JUSTIFICATION FOR CO-PO MAPPING

MAPPING	**LEVEL**	**JUSTIFICATION**

CO1- PO1	3	Students will learn digital logic and Boolean algebra.
CO1- PO2	3	Students will analyze digital representation of information to decide on the type of circuits.
CO2- PO1,	3	Students will learn the working and design of combinational circuits.
CO2-PO2	3	Students will analyze the circuit requirements through truth tables for the design of combinational circuits.
CO2- PO3	3	Students will perform design of combinational circuits.
CO3- PO1	3	Students will learn the working of different types of logic families.
CO3- PO2	3	Students will analyze the behavior of various logic families to make decisions, on the type of logic families to be chosen, for various applications.
CO4- PO1	3	Students will learn the working and design of sequential circuits.
CO4- PO2	3	Students will analyze the requirements and make conclusions on the type of circuits to be designed
CO4- PO3	3	Students will perform design of sequential circuits.
CO5- PO1	3	Students will learn and apply the Knowledge of Logic circuit design to describe its behavior in Verilog HDL.
CO5- PO2	3	Students will analyze the simulation output to verify the correctness of the HDL model.
CO5- PO3	3	Students will be able the design HDL models of digital circuits(problems) using Verilog.
CO5- PO5	3	Students will study and perform programming of Verilog HDL.

JUSTIFICATION FOR CO-PSO MAPPING

MAPPING	**LEVEL**	**JUSTIFICATION**
CO1-PSO1	3	Students will learn digital logic and Boolean algebra.

CO2-PSO1	3	Students will learn the working and design of combinational circuits.
CO3-PSO1	3	Students will learn the working of different types of logic families.
CO4-PSO1	3	Students will learn the working and design of sequential circuits.
CO5-PSO2	3	Students will learn and apply modern tools such as Verilog HDL to design and analyze logic circuits.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl No	**DESCRIPTION**	**PROPOSED ACTIONS**	**PO MAPPING**
1	Familiarization of HDL tools through hands on session	Conduct hands on session for Verilog HDL	PO-5

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

Sl No	**DESCRIPTION**	**PO MAPPING**
2	Implementation of digital circuit designs on FPGA	PO-3, PO-5

WEB SOURCE REFERENCES:

1	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/digital_circuit/frame/
2	http://www.electronics-tutorials.ws/logic/logic_1.html

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

✓ CHALK & TALK	✓ STUD. ASSIGNMENT	✓ WEB RESOURCES	
☐ LCD/SMART BOARDS	✓ STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS	☐ STUD. SEMINARS	✓ TESTS/MODEL EXAMS	✓ UNIV. EXAMINATION
✓ STUD. LAB PRACTICES	✓ STUD. VIVA	✓ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by

Dr. Rithu James

Dr. Jayanthi V S **Approved by**

Dr. Jaison Jacob

(HOD)

COURSE PLAN

No	Topic	No. of Lectures
1	**Number Systems and Codes: (12 hours)**	
1.1.	Binary, octal and hexadecimal number systems; Methods of base conversions;	2
1.2	Binary, octal and hexadecimal arithmetic;	1
1.3	Representation of signed numbers; Fixed and floating point numbers;	3
1.4	Binary coded decimal codes; Gray codes; Excess 3 code :	1
1.5	Error detection and correction codes - parity check codes and Hamming code- Alphanumeric codes: ASCII	3
1.6	Verilog basic language elements: identifiers, data objects, scalar data types, operators	2
2	**Boolean Postulates and Fundamental Gates: (7 hours)**	
2.1	Boolean postulates and laws – Logic Functions and Gates, De-Morgan's Theorems, Principle of Duality	2
2.2	Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS)	2
2.3	Canonical forms, Karnaugh map Minimization	1
2.4	Gate level modelling in Verilog: Basic gates, XOR using NAND and NOR	2
3	**Combinatorial and Arithmetic Circuits: (8 hours)**	
3.1	Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers	2
3.2	Encoder, Decoder, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder	3
3.3	Gate level modelling combinational logic circuits in Verilog: half adder, full adder, mux, demux, decoder, encoder	3

4	**Sequential Logic Circuits: (11 hours)**	
4.1	Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF	2
4.2	Conversion of Flipflops, Excitation table and characteristic equation.	1
4.3	Ripple and Synchronous counters, Shift registers-SIPO.SISO,PISO,PIPO	2
4.4	Ring counter and Johnsons counter, Asynchronous and Synchronous counter design	3
4.5	Mod N counter, Random Sequence generator	1
4.6	Modelling sequential logic circuits in Verilog: flipflops, counters	2
5	**Logic families and its characteristics: (7 hours)**	
5.1	TTL, ECL, CMOS- Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product.	3
5.2	TTL inverter - circuit description and operation	1
5.3	CMOS inverter - circuit description and operation	1
5.4	Structure and operations of TTL and CMOS gates; NAND in TTL, NAND and NOR in CMOS.	2

MODEL QUESTION PAPER

RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

THIRD SEMESTER B.TECH DEGREE EXAMINATION

Course: 100902/EC300C Logic Circuit Design

Time: 3 Hrs **Max. Marks: 100**

PART A

(Answer all questions, each question carries 3 marks)

1. Convert 203.5210to binary and hexadecimal.
2. Compare bitwise and logical verilog operators.
3. Prove that NAND and NOR are not associative.
4. Convert the expression ABCD+ABC'+ACD to minterms.
5. Define expressions in Verilog with example.
6. Explain the working of a decoder.
7. What is race around condition?
8. Convert a T flip-flop to D flip-flop.
9. Define fan-in and fan-out of logic circuits.
10. Define noise margin and how can you calculate it?

PART B

(Answer one question from each module. Each question carries 14 marks)

Module I

11. (A) Subtract 4610 from 10010 using 2's complement arithmetic. (8)

(B) Give a brief description on keywords and identifiers in Verilog with example (6)

OR

12. (A) Explain the floating and fixed point representation of numbers (8)

(B) Explain the differences between programming languages and HDLs (6)

Module II

13. (A) Simplify using K-map, $F(A,B,C,D) = \Sigma\, m(4,5,7,8,9,11,12,13,15)$ (7)

(B) Write a Verilog code for implementing above function (7)

OR

14. (A) Write a Verilog code to implement the basic gates. (7)

(B) Reduce the following Boolean function using K-Map and implement the simplified function using the logic gates

$F(A,B,C,D) = \Sigma\, m(0,1,4,5,6,8,9,10,12,13,14)$ (7)

Module III

15. (A) Design a 3-bit magnitude comparator circuit. (8)

(B) Write a Verilog description for a one bit full adder circuit. (6)

OR

16. (A) Write a verilog code to implement 4:1 multiplexer. (6)

(B) Implement the logic function $F(A,B,C) = \Sigma\, m(0,1,4,7)$ using 8:1 and 4:1 multiplexers (8)

Module IV

17. Design MOD 12 asynchronous counter using T flip-flop. (14)

OR

18. (A) Explain the operation of Master Slave JK flip-flop. (7)

(B) Derive the output Qn+1 in Terms of Jn, Kn and Qn (7)

Module V

19. (A) Explain in detail about TTL with open collector output configuration (8)

(B) Draw an ECL basic gate and explain. (6)

OR

20. (A) Demonstrate the CMOS logic circuit configuration and characteristics in detail. (8)

(B) Compare the characteristics features of TTL and ECL digital logic families (6)

EC 468

NETWORK THEORY

COURSE INFORMATION SHEET

PROGRAMME: ELECTR ONICS & COMMUNICATION ENGINEERING	DEGREE: B. TECH
COURSE: NETWORK THEORY	SEMESTER: 3 CREDITS: 4
COURSE CODE: 100902/EC300D REGULATION: 2021	COURSE TYPE: CORE
COURSE AREA/DOMAIN: ELECTRONIC CIRCUITS	CONTACT HOURS: 4 hrs.
CORRESPONDING LAB COURSE CODE (IF ANY): Nil	LAB COURSE NAME: Nil

SYLLABUS:

Module 1: Mesh and Node Analysis

Mesh and node analysis of network containing independent and dependent sources. Supermesh and Supernode analysis. Steady-state AC analysis using Mesh and Node analysis.

Module 2: Network Theorems

Thevenin’s theorem, Norton’s theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem. (applied to both dc and ac circuits having dependent source).

Module 3: Application of Laplace Transforms

Review of Laplace Transforms and Inverse Laplace Transforms, Initial value theorem & Final value theorem, Transformation of basic signals and circuits into s-domain. Transient analysis of RL, RC, and RLC networks with impulse, step, and sinusoidal inputs (with and without initial conditions). Analysis of networks with transformed impedance and dependent sources.

Module 4: Network functions

Network functions for the single port and two port networks. Properties of driving point and transfer functions. Significance of Poles and Zeros of network functions, Time domain response from pole zero plot. Impulse Function & Response. Network functions in the sinusoidal steady state, Magnitude, and Phase response.

Module 5: Two port network Parameters

Impedance, Admittance, Transmission and Hybrid parameters of two port network. Interrelationship among parameter sets. Series and parallel connections of two port networks. Reciprocal and Symmetrical two port network. Characteristic impedance, Image impedance and propagation constant (derivation not required).

Page Break

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T1	Valkenburg V., "Network Analysis," Pearson, 3/e, 2019.
T2	Sudhakar A, Shyammohan S. P., "Circuits and Networks- Analysis and Synthesis," McGraw Hill,
R1	Edminister, "Electric Circuits – Schaum's Outline Series," McGraw-Hill, 2009.
R2	2. W. Hayt, J. Kemmerly, J. Phillips, S. Durbin, "Engineering Circuit Analysis," McGraw Hill.
R3	2. K. S. Suresh Kumar, "Electric Circuits and Networks", Pearson, 2008.
R4	3. William D. Stanley, "Network Analysis with Applications", 4/e, Pearson, 2006.

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME
100908/CO900F	Basics of Electrical and Electronics Engineering
100908/MA200A	Vector Calculus, Differential Equations and Transforms (Laplace Transform)

COURSE OBJECTIVES:

1	To familiarize students with analysis of linear time invariant electronic circuits.

COURSE OUTCOMES:

Sl. No	**DESCRIPTION**	**Blooms' Taxonomy Level**
1	Graduates will be able to **understand** and **list** various methods like Mesh / Node analysis or Network Theorems to obtain steady state response of the linear time invariant networks.	Remember & Understand (Level 1, 2)
2	Graduates will be able to **examine** and a**pply** Laplace Transforms to determine the transient behaviour of RLC networks.	Understand & Apply (Level 2, 3)
3	**Apply** Network functions and Network Parameters to **analyse** the single port and two port networks.	Apply & Analyse (Level 3, 4)

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3										2	2		
2	3	3										2	2		
3	3	3										2	2		
100902/ EC300D	3	3										2	2		

Page Break

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE

	PO1	**PO2**	**PO12**	**PSO1**
CO1	Basics for real-world electrical network & electronic circuit analysis	Techniques for circuit analysis under different conditions like dependent sources, dc circuits, ac circuits etc.	Lays foundation for more advanced topics in network theory and analysis	Principles & techniques learnt can be extended to many future courses like electronic circuits,

				electromagnetic theory etc.
CO2	Applying Laplace transform covered in mathematics to a specific engineering problem	Using Laplace transforms to perform frequency domain analysis of circuits and extending analysis to excitations beyond sinusoids	Provides scope for more advanced analysis of circuits in the frequency domain	Principles & techniques learnt can be extended to many future courses like electronic circuits, electromagnetic theory etc.
CO3	Network modelling and generalization.	Expressing networks using different parameter sets and simplifying analysis based on problem at hand	Leads to more complex topics like circuit stability analysis, transmission line concepts etc.	Principles & techniques learnt can be extended to many future courses like electronic circuits, electromagnetic theory etc.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl. No.	**DESCRIPTION**	**PROPOSED ACTIONS**	**PO MAPPING**
1	System modeling and analysis- checking stability and energy conservation.	Assignments on Laplace Transform, Z transform etc.	PO1, PO2, PO3, PO4, PO5, PO12
2	Solving first order linear homogeneous and non-homogeneous equations	Assignment (Mathematics)	PO1, PO2, PO3, PO4, PO5, PO12

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

Sl. No.	**DESCRIPTION**	**PO MAPPING**
1	Introduction to PSpice	PO1, PO2, PO3, PO4, PO5
2	MATLAB examples	PO1, PO2, PO3, PO4, PO5

WEB SOURCE REFERENCES:

1	NPTEL, IITK: Network Analysis
2	MIT open courseware: Circuits and electronics
3	Open courses Eastern Mediterranean University: EENG223 Circuit Theory I

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☐ CHALK & TALK	☐ STUD. ASSIGNMENT	☐ ONLINE PLATFORM	☐ WEB RESOURCES
☐ LCD/SMART BOARDS	☐STUD. SEMINARS	☐ ADD-ON COURSES	

Page Break

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS	☐STUD. SEMINARS	☐ STUD. VIVA	☐ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ TESTS/MODEL EXAMS	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY
☐ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by Approved by

Ms. Liza Annie Joseph Dr. Rithu James

Ms. Maleeha Abdul Azeez (HoD)

Ms. Anila Kuriakose

Mr. Kiran K A

COURSE PLAN

No	Topic	No. of Lectures
1	**Mesh and Node Analysis**	
1.1	Review of circuit elements and Kirchhoff's Laws.	2
1.2	Independent and dependent Sources, Source transformations.	1
1.3	Mesh and node analysis of network containing independent and dependent sources.	3
1.4	Supermesh and Supernode analysis.	1
1.5	Steady-state AC analysis using Mesh and Node analysis.	3
2	**Network Theorems (applied to both dc and ac circuits having dependent source)**	
2.1	Thevenin's theorem.	1
2.2	Norton's theorem.	1
2.3	Superposition theorem.	2
2.4	Reciprocity theorem.	1
2.5	Maximum power transfer theorem.	2
3	**Application of Laplace Transforms**	
3.1	Review of Laplace Transforms.	2
3.2	Initial value theorem & Final value theorem (Proof not necessary).	1
3.3	Transformation of basic signals and circuits into s-domain.	2
3.4	Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs.	3

3.5	Analysis of networks with transformed impedance and dependent sources.	3
4	**Network functions**	
4.1	Network functions for the single port and two port networks.	2
4.2	Properties of driving point and transfer functions.	1
4.3	Significance of Poles and Zeros of network functions, Time domain response from pole zero plot.	1
4.4	Impulse Function & Response.	1
4.5	Network functions in the sinusoidal steady state, Magnitude and Phase Response.	3

5	**Two port network Parameters**	
5.1	Impedance, Admittance, Transmission and Hybrid parameters of two port network.	4
5.2	Interrelationship among parameter sets.	1
5.3	Series and parallel connections of two port networks.	2
5.4	Reciprocal and Symmetrical two port network.	1
5.5	Characteristic impedance, Image impedance and propagation constant (Derivation not required).	1

Model Question paper

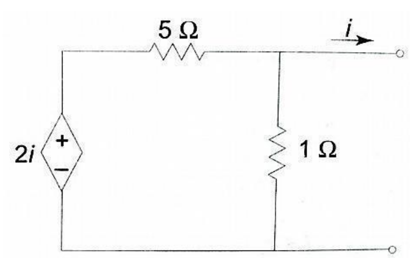
RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)
THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

100902/EC300D NETWORK THEORY

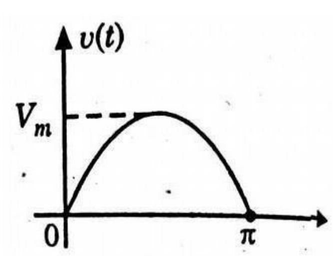
Max. Marks: 100 Duration: 3 Hours

PART A
(Answer ALL Questions. Each Carries 3 mark.)

1. Illustrate the source-transformation techniques.
2. Explain the concept of supernode.
3. State and prove Maximum Power Transfer theorem



4. Evaluate the Norton's equivalent current in the following circuit.

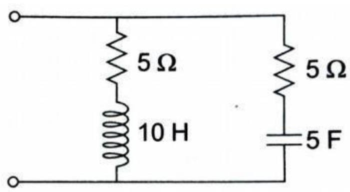


5. Evaluate the Laplace Transform of half-wave rectified sine pulse.

6. Give the two forms of transformed impedance equivalent circuit of a capacitor with initial charge across it.

7. Enumerate necessary condition for a Network Functions to be Transfer Functions.

8. Obtain the pole zero configuration of the impedance function of the following circuit.



9. Define the short-circuit admittance parameter with its equivalent circuit.

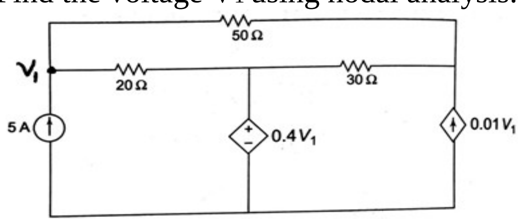
10. Deduce Z-parameter in terms of h-parameter.

PART – B

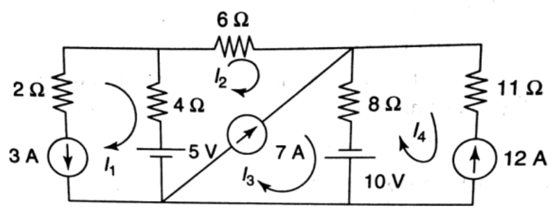
(Answer one question from each module; each question carries 14 marks.)

Module - I

11. (a) Find the voltage V_1 using nodal analysis.

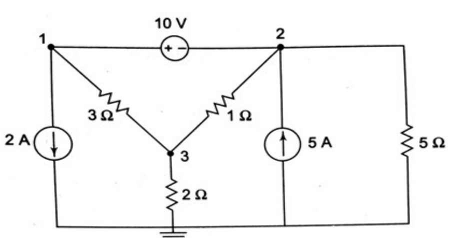


(b) Find the current through 8 ohms resistor in the following circuit using mesh analysis.

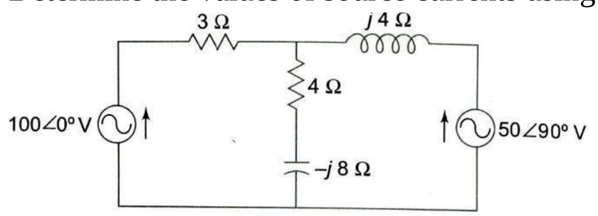


OR

12. (a) Find the power delivered by the 5A current source using nodal analysis method.

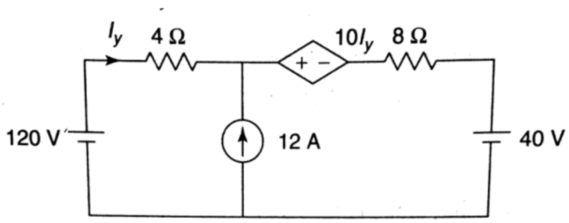


b. Determine the values of source currents using Mesh analysis

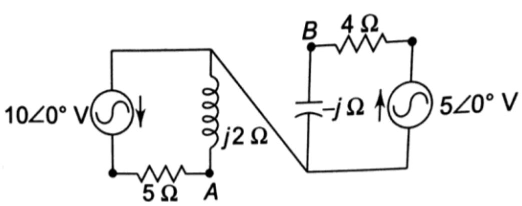


Module - II

13. (a) Find the current I_y by superposition principle.

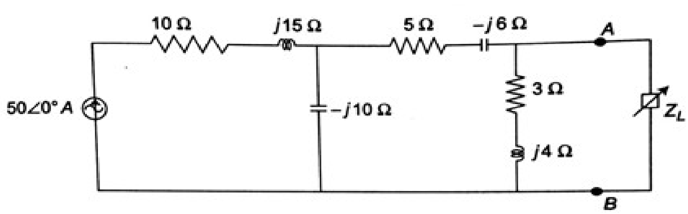


b. Find the Norton's equivalent circuit across the port AB.



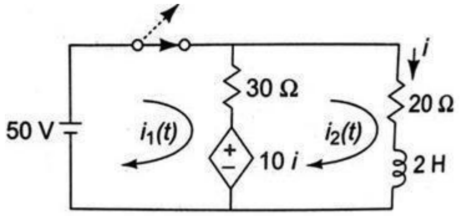
OR

14. Determine the maximum power delivered to the load in the circuit.



Module - III

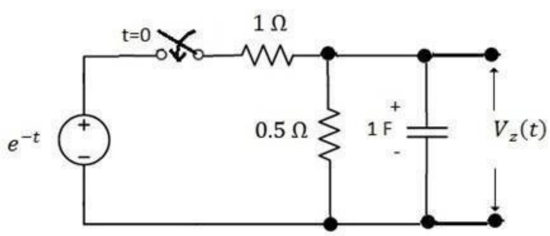
15. (a) The switch is opened at t = 0 after steady state is achieved. Find the expression for the transient current i.



b. A voltage pulse of unit height and width 'T' is applied to a low pass RC circuit at time t=0. Determine the expression for the voltage across the capacitor C as a function of time.

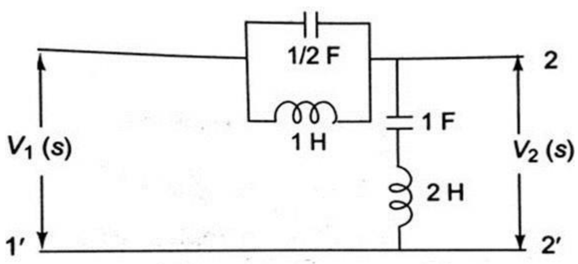
OR

16. In the circuit, the switch is closed at $t = 0$, connecting a source e^{-t} to the RC circuit. At time $t = 0$, it is observed that capacitor voltage has the value $V(0) = 0.5V$. For the element values given, determine $V(t)$ after converting the circuit into transformed domain.



Module - IV

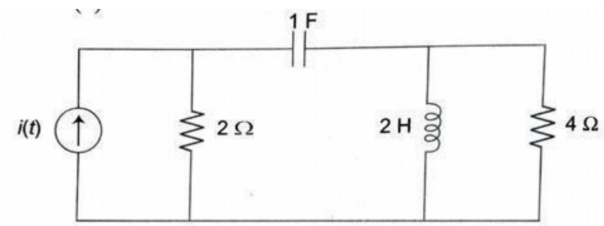
17. For the network, determine Driving point impedance Z_{11} (s), Voltage gain Transfer function G_{21}(s) and Current gain Transfer function α_{21}(s).



OR

18. (a) Compare and contrast the necessary conditions for a network Driving point function and Transfer functions.

b. For following network, evaluate the admittance function Y(s) as seen by the source i(t). Also pot the poles and zeros of Y(s).



Module - V

19. (a) Deduce the transmission parameters of two port network in terms of

(i) Z-parameters, (ii) Y-parameters and (iii) Hybrid parameters.

(b) How to determine the given two port network is Symmetrical.

OR

20.

Two identical sections of the following networks are connected in parallel. Obtain the Y-parameters of the combination.

100908/CO300F

SUSTAINABLE ENGINEERING

COURSE INFORMATION SHEET

PROGRAMME: ELECTRONICS & COMMUNICATION ENGINEERING	DEGREE: B. TECH
COURSE: SUSTAINABLE ENGINEERING	SEMESTER: 3 CREDITS: NIL
COURSE CODE: 100908/CO300F REGULATION: 2021	COURSE TYPE: NON- CORE
COURSE AREA/DOMAIN: HUMANITIES	CONTACT HOURS: 2 hrs.
CORRESPONDING LAB COURSE CODE (IF ANY): Nil	LAB COURSE NAME: Nil

SYLLABUS:

Module 1: Sustainability

Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

Module 2: Environmental Pollution

Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

Module 3: Environmental management standards

ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Module 4: Resources and its utilisation

Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

Module 5: Sustainability practices

Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION

T1	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
T2	Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
R1	Environment Impact Assessment Guidelines, Notification of Government of India, 2006
R2	Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
R3	Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
R4	Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

COURSE PRE-REQUISITES: NIL

--	Basic Sciences- Physics, Chemistry, Biology, Geography (High School Level)

COURSE OBJECTIVES:

1	To inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

COURSE OUTCOMES:

Sl. No	DESCRIPTION
1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
2	Explain the different types of environmental pollution problems and their sustainable solutions
3	Discuss the environmental regulations and standards.
4	Outline the concepts related to conventional and non-conventional energy
5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**

1						2	3					2			2
2						2	3					2			2
3						2	3					2			2
4						2	3					2			2
5						2	3					2			2
ECT205						2	3					2			**2**

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE

<table>
<tr><th></th><th>PO6</th><th>PO7</th><th>PO12</th><th>PSO3</th></tr>
<tr><td>CO1</td><td>The knowledge about the concept and importance of sustainability will help the student to focus better on societal, health, safety and cultural aspects of his/her profession</td><td rowspan="5">The course entirely deals with environment and sustainablity, and thus all the course outomes fully contributes to this programme outcome
The course entirely deals with environment and sustainablity, and thus all the course outomes fully contributes to this programme outcome</td><td>Sustainable engineering is one of the elements of ethical engineering practices.</td><td rowspan="5">Each of the COs creates an awareness in the student about carrying out their responsibilities with due the consideration towards environment protection and sustainability.</td></tr>
<tr><td>CO2</td><td>Student's understanding of causes, effects and control of pollution contributes to making him/her a responsible engineer</td><td>Provides scope for implementation of strategies to curb environmental pollution</td></tr>
<tr><td>CO3</td><td>Student's basic knowledge of environmental standards and environmental impact assessment will guide him/her in the assessment of his/her engineering practice.</td><td>Leads to more efficient energy management systems based on EIA</td></tr>
<tr><td>CO4</td><td>The understanding of basic concepts on conventional and non conventional energy sources will enable the student to understand importance of energy efficient systems</td><td>Leads to more efficient utilization of resource and energy consumption</td></tr>
<tr><td>CO5</td><td>The student's understanding of sustainable devlopment will help him be a responsible engineer working for the benefit of the society.</td><td>Helps the student to opt for sustainable energy resources where applicable in the project.</td></tr>
</table>

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl No	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING

1	Practical Case studies	Discussions, Presentations	PO6, PO7, PO12

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

Sl No	DESCRIPTION	PO MAPPING
1	Group Discussions	PO6, PO7, PO9, PO10
2	Seminars & Projects	PO6, PO7, PO9, PO10

WEB SOURCE REFERENCES:

1	http://www.pittstate.edu/office/president/initiatives/sustainability/what-is-sustainability.dot
2	http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm
3	http://unfccc.int/kyoto_protocol/mechanisms/
4	http://www.epa.gov/
5	http://ecometrica.com/assets/whatis_acarbonfootprint_summary.pdf

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

~~☐ CHALK & TALK~~	☐ STUD. ASSIGNMENT	☐ WEB RESOURCES
☐LCD/SMART BOARDS	☐STUD. SEMINARS	~~☐ ADD-ON COURSES~~

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS	☐STUD. SEMINARS	☐ TESTS/MODEL EXAMS	☐ UNIV. EXAMINATION
☐ ~~STUD. LAB PRACTICES~~	~~☐ STUD. VIVA~~	~~☐ MINI/MAJOR PROJECTS~~	~~☐ CERTIFICATIONS~~
☐~~ADD-ON COURSES~~	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY

□~~ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS~~	~~□ OTHERS~~

Prepared by | **Approved by**

Ms. Mariya Vincent
Dr. Suma H

Dr. Rithu James
(HoD)

COURSE PLAN

No	Topic	Number of Lectures
1	**Module 1 (5 Hours)**	
1.1	Introduction, concept, evolution of the concept	1
1.2	Social, environmental and economic sustainability concepts	1
1.3	Sustainable development, Nexus between Technology and Sustainable development	1
1.4	Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)	1
1.5	Clean Development Mechanism (CDM)	1
2	**Module 2 (6 Hours)**	
2.1	Air Pollution and its effects	1
2.2	Water pollution and its sources	1
2.3	Zero waste concept and 3 R concepts in solid waste management	1
2.4	Greenhouse effect, Global warming, Climate change, Ozone layer depletion	1
2.5	Carbon credits, carbon trading and carbon foot print.	1
2.6	Legal provisions for environmental protection.	1
3	**Module 3 (5 Hours)**	
3.1	Environmental management standards	1
3.2	ISO 14001:2015 frame work and benefits	1
3.3	Scope and Goal of Life Cycle Analysis (LCA)	1
3.4	Circular economy, Bio-mimicking	1
3.5	Environment Impact Assessment (EIA)	1
4	**Module 4 (4 Hours)**	
4.1	Basic concepts of Conventional and non-conventional energy	1
4.2	General idea about solar energy, Fuel cells	1
4.3	Wind energy, Small hydro plants, bio-fuels	1
4.4	Energy derived from oceans and Geothermal energy	1
5	**Module 5 (4 Hours)**	
5.1	Basic concept of sustainable habitat	1
5.2	Methods for increasing energy efficiency of buildings	1

MODEL QUESTION BANK

Module 1

- Illustrate the three-pillar model of sustainability.
- What are the three levels with which you approach a sustainable issue? Explain with an example.
- Comment on the challenges for sustainable development in our country and suggest a way to overcome the same.
- What is the main motto of the Clean Development Mechanism (CDM)? Relate the same to the suggestions of Kyoto protocol.
- How would you take initiatives in conducting your college fest, so that it remains an environmentally sustainable one?
- Justify, giving one reason, why sustainability is an essential component in any developmental programmes and projects.
- Comment on any one challenge experienced in the implementation of sustainable development principles.
- Write a short note on MDGs
- Write a short note on SDGs

Module 2

- Apply 3R concept to mineral water bottles.
- Distinguish between carbon credits and carbon trading.
- List out any two methods by which carbon foot print can be reduced.
- Explain the significance of carbon footprint. Suggest some methods for reducing the carbon footprint of your house.
- A hospital is situated in the middle of a densely populated area. What are the possible environmental impacts that can happen to the surroundings? Suggest any methods for reducing these impacts.
- What do you mean by greenhouse effect? List any three GHGs.
- Briefly describe zero waste concept with a suitable example.
- Using any one example illustrate the concept of 3R’s in solid waste management.
- “No Challenge poses a greater threat to future generation than climate change”-Barack Obama. Enumerate the recent effects of climate change.

Module 3

- Can we use life cycle analysis (LCA) as a tool for profit making? How?
- Conduct a sample life cycle analysis of any product given below Plastic pet bottles, lead acid batteries or hollow bricks.
- Life cycle assessment takes the concept of “cradle to grave”. Explain this with any example
- List any 5 products developed bases on bio mimics.
- Discuss the benefits of doing an EIA study.

- Write a short note on EMS. Briefly indicate the steps involved in introducing EMS in an industry.
- What is Bio-mimicking?
- List out the procedures of EIA followed in India.
- With a suitable example, explain the principles of industrial symbiosis
- What is LCA? Illustrate how LCA can be effectively used in the environmental management of industrial production systems.

Module 4

- Suggest two renewable energy sources for our state and validate your suggestion
- Explain different method using which we can utilize solar energy.
- Differentiate between conventional and nonconventional energy sources. Which will you support? Why?
- "We can create a more Sustainable, cleaner and safer world by making wiser energy choices." Evaluate the importance of the quote and discuss on the various Non-Conventional Energy Sources
- What are limitations in harnessing the tidal energy?
- Being an agriculture country, what is the scope of using bio-fuels for meeting the energy needs of India?
- What is the scope of using geothermal energy as a non-renewable energy source?
- Give suggestions to reduce the power consumption at the place where you are studying, enumerating the unwanted/ wastage of power
- What are the prospects of using Biofuel as a renewable energy source?

Module 5

- Take an example of green building. How it differs from a conventional building. Compare in any six aspects
- Transportation sector is the major source of pollution in the cities. What are the factors pointing to this statement? Suggest some methods to deal with traffic issues in urban areas.
- Discuss any three benefits of green engineering.
- What are the basic features of a sustainable city?
- Does green building more expensive than traditional building? Why?
- Enumerate the basic features of a sustainable habitat

100001/EC322S

SCIENTIFIC COMPUTING LAB

COURSE INFORMATION SHEET

PROGRAMME: ELECTRONICS & COMMUNICATION	DEGREE: BTECH
COURSE: SCIENTIFIC COMPUTING LAB	SEMESTER: 3 CREDITS: 2
COURSE CODE: 100001/EC322S REGULATION: Autonomous	COURSE TYPE: CORE
COURSE AREA/DOMAIN: ELECTRONICS	CONTACT HOURS: 0+0+3 (LAB) hours/Week.
CORRESPONDING THEORY COURSE CODE (IF ANY): NIL	THEORY COURSE NAME:NIL

SYLLABUS:

Sl.NO	DETAILS	HOURS
1	Familarization of the Computing Tool	3
2	Familarization of Scientific Computing	3
3	Realization of Arrays and Matrices	3
4	Numerical Differentiation and Integration	3
5	Solution of Ordinary Differential Equations	3
6	Simple Data Visualization	3
7	Simple Data Analysis with Spreadsheets	3
8	Convergence of Fourier Series	3
9	Coin Toss and the Level Crossing Problem	3
TOTAL HOURS		27

TEXT/REFERENCE BOOKS:

1	DIGITAL SIGNAL PROCESSING USING MATLAB by Vinay K. Lngle, John G. Proakis.
2	Digital Signal Processing Laboratory Using MATLAB by Sanjit K Mitra.

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
101908/MA100A	Linear Algebra and Calculus	**Theory**	**1**
100908/MA200A	Vector Calculus, Differential Equations and Transforms	**Theory**	**2**

COURSE OBJECTIVES:

1	To translate the mathematical concepts into system design.
2	To familiarize with computing tools such as Matlab and Python
3	The experiments will lay the foundation for future labs such as DSP lab.

COURSE OUTCOMES:

SNO	DESCRIPTION	Bloom Taxonomy Level
1	Describe the needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization	Understand (Level 2)

2	Approximate an array/matrix with matrix decomposition.	Understand and Analyze (Level 2 & 4)
3	Implement numerical integration and differentiation.	Analyze and Apply (Level 4 & 6)
4	Solve ordinary differential equations for engineering applications	Analyze and Apply (Level 4 & 6)
5	Compute with exported data from instruments	Analyze & Apply (Level 4 & 6)
6	Realize how periodic functions are constituted by sinusoids	Analyze and Apply (Level 4 & 6)
7	Simulate random processes and understand their statistics.	Analyze and Apply (Level 4 & 6)

CO – PO mapping

CO No	Programme Outcomes (POs)												Programme Specific Outcome (PSOs)		
	PO 1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO9	PO1 0	PO11	PO1 2	PSO1	PSO2	PSO3
1	3	2												2	
2	2	1			1									2	
3		2			1									2	
4	2	3			2									1	

5		3			2									1	
6	1	2			2									1	
7	2				2								1	1	

Justification

Mapping	Justification
CO1-PO1	Understanding scientific computing tool for the solution of complex computational problems
CO1-PO2	Analyzing the solutions for basic computation problems
CO2-PO1	Understanding matrix decomposition using scientific computing tool
CO2-PO2	Analyzing different matrix operations
CO2-PO5	Using a modern scientific computing tool for matrix operations
CO3-PO2	Analyzing and implementing numerical integration and differentiation.
CO3-PO5	Using a modern scientific computing tool for numerical integration and differentiation
CO4-PO1	Understanding the methods of solving ordinary differential equations
CO4-PO2	Analyzing differential equations and finding solutions
CO.4-PO5	Using a modern scientific computing tool for solving differential equations
CO5-PO2	Analyzing exported data from instruments
CO5-PO5	Using a modern scientific computing tool for analyzing exported data from instruments
CO6-PO1	Understanding how periodic functions are constituted by sinusoids
CO6-PO2	Analyzing periodic functions
CO6-PO5	Using a modern scientific computing tool for analyzing periodic functions

CO7-PO1	Understand random processes and their statistics
CO7-PO5	Using a modern scientific computing tool for analyzing random processes and their statistics.
CO1-PSO2	Knowledge of scientific computing tool
CO2-PSO2	Apply the knowledge of scientific computing tool for matrix decomposition
CO3-PSO2	Apply the knowledge of scientific computing tool for numerical integration and differentiation
CO4-PSO2	Apply the knowledge of scientific computing tool for solving ordinary differential equations
CO5-PSO2	Apply the knowledge of scientific computing tool for computing with exported data from instruments
CO6-PSO2	Apply the knowledge of scientific computing tool to realize periodic functions are constituted by sinusoids
CO7-PSO1	Knowledge of simulating random processes and understanding their statistics
CO7-PSO2	Apply the knowledge of scientific computing tool to simulate and understand random process.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SNO	DESCRIPTION	PROPOSED ACTIONS	**RELEVANCE WITH POs**	**RELEVANCE WITH PSOs**
	Solution of representative problems encountered in scientific computation.	Assignments		

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SNO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
	Solve differential equations for diffusion current in solid state device physics	Assignment		

WEB SOURCE REFERENCES:

1	http://www.mathworks.com

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☐ CHALK & TALK ☐	☐ STUD. ASSIGNMENT ☐	☐ WEB RESOURCES ☐	☐ LCD/SMART BOARDS
☐ STUD. SEMINARS	☐ ADD-ON COURSES ☐		

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS ☐	☐ STUD. SEMINARS	☐ TESTS/MODEL EXAMS ☐	☐ UNIV. EXAMINATION ☐
☐ STUD. LAB PRACTICES ☐	☐ STUD. VIVA ☐	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	STUDENT FEEDBACK ON FACULTY (TWICE)
ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	OTHERS

Prepared by **Approved by**

Ms. Swapna Davis **Dr. Rithu James**

Dr. Simi Zerine Sleeba

Ms.Mariya Vincent

COURSE PLAN

Sl.NO	DETAILS	HOURS
1	Familarization of the Computing Tool	3
2	Familarization of Scientific Computing	3
3	Realization of Arrays and Matrices	3
4	Numerical Differentiation and Integration	3
5	Solution of Ordinary Differential Equations	3
6	Simple Data Visualization	3
7	Simple Data Analysis with Spreadsheets	3
8	Convergence of Fourier Series	3
9	Coin Toss and the Level Crossing Problem	3
TOTAL HOURS		27

100001/EC322T

LOGIC DESIGN LAB

COURSE INFORMATION SHEET

PROGRAMME: Electronics & Communication Engineering	DEGREE: B.TECH (Autonomous)
COURSE: Logic Design Lab	SEMESTER: 3 CREDITS: 2
COURSE CODE: 100902/EC322T REGULATION: 2019	COURSE TYPE: CORE
COURSE AREA/DOMAIN: Digital Electronics	CONTACT HOURS: 3 hrs.
CORRESPONDING THEORY COURSE CODE (IF ANY):100902/EC 300C	THEORY COURSE NAME: Logic Circuit Design

SYLLABUS:

Unit	Details	Hrs
	It is compulsory to conduct a minimum of 5 experiments from Part A and a minimum of 5 experiments from Part B.	
	Part A (Any 5)	
	The following experiments can be conducted on breadboard or trainer kits.	
1	Realization of functions using basic and universal gates (SOP and POS forms).	3 hr.
2	Design and Realization of half /full adder and subtractor using basic gates and universal gates.	3 hr.
3	4-bit adder/subtractor and BCD adder using 7483.	3 hr.
4	Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.	3 hr.

5	Asynchronous Counter:3 bit up/down counter	3 hr.
6	Asynchronous Counter: Realization of Mod N counter	3 hr.
7	Synchronous Counter: Realization of 4-bit up/down counter.	3 hr.
8	Synchronous Counter: Realization of Mod-N counters.	3 hr.
9	Ring counter and Johnson Counter. (Using FF & 7495).	3 hr.
10	Realization of counters using IC’s (7490, 7492, 7493).	3 hr.
11	Multiplexers and De-multiplexers using gates and ICs. (74150, 74154)	3 hr.
12	Realization of combinational circuits using MUX & DEMUX.	3 hr.
13	Random Sequence generator using LFSR.	3 hr.
	PART B (Any 5)	
The following experiments aim at training the students in digital circuit design with verilog and implementation in small FPGAs. Small, low cost FPGAs, that can be driven by open tools for simulation, synthesis and place and route, such as *TinyFPGA* or *Lattice iCEstick* can be used. Open software tools such as *yosis* (for simulation and synthesis) and *arachne* (for place and route) may be used. The experiments will lay the foundation for digital design with FPGA with the objective of increased employability.		
1	Experiment 1. Realization of Logic Gates and Familiarization of FPGAs	3 hr.
	(a) Familiarization of a small FPGA bboard and its ports and interface.	
	(b) Create the .pcf files for your FPGA board.	
	(c) Familiarization of the basic syntax of Verilog	
	(d) Development of verilog modules for basic gates, synthesis and implementation in the above FPGA to verify the truth tables.	
	(e) Verify the universality and non associativity of NAND and NOR gates by uploading the corresponding verilog files to the FPGA boards.	

2	Experiement 2: Adders in Verilog	3 hr.
	(a) Development of verilog modules for half adder in 3 modeling styles (dataflow/structural/	
	behavioural).	
	(b) Development of verilog modules for full adder in structural modeling using half adder.	
3	Experiement 3: Mux and Demux in Verilog	
	(a) Development of verilog modules for a 4x1 MUX.	
	(b) Development of verilog modules for a 1x4 DEMUX.	
4	Experiement 4: Flipflops and coutners	3 hr.
	(a) Development of verilog modules for SR, JK and D flipflops.	
	(b) Development of verilog modules for a binary decade/Johnson/Ring counters	
5	Experiment 5. Multiplexer and Logic Implementation in FPGA	3 hr.
	(a) Make a gate level design of an 8 : 1 multiplexer, write to FPGA and test its functionality.	
	(b) Use the above module to realize the logic function f (A, B, C) = $\sum m(0, 1, 3, 7)$ and test it.	
	(c) Use the same 8 : 1 multiplexer to realize the logic function f (A, B, C, D) = $\sum m(0, 1, 3, 7, 10, 12)$ by partitioning the truth table properly and test it.	
6	Experiment 6. Flip-Flops and their Conversion in FPGA	3 hr.
	(a) Make gate level designs of J-K, J-K master-slave, T and D flip-flops, implement and test them on the FPGA board.	
	(b) Implement and test the conversions such as T to D, D to T, J-K to T and J-K to D in FPGA	
7	Experiment 7: Asynchronous and Synchronous Counters	3 hr.

	(a) Make a design of a 4-bit up down ripple counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board.	
	(b) Make a design of a 4-bit up down synchronous counter using T-flip-lops in the previous experiment, implement and test them on the FPGAboard.	
8	Experiment 8: Universal Shift Register in FPGA	3 hr.
	(a) Make a design of a 4-bit universal shift register using D-flip-flops in the previous	
	experiment, implement and test them on the FPGA board.	
	(b) Implement ring and Johnson counters with it.	
9	Experiment 9. BCD to Seven Segment Decoder in FPGA	3 hr.
	(a) Make a gate level design of a seven segment decoder, write to FPGA and test its	
	functionality.	
	(b) Test it with switches and seven segment display. Use ouput ports for connection to the display.	
	Total hrs.	

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
1	Mano M. M., Digital Logic & Computer Design, 4/e, Pearson Education, 2013.
2	Floyd T. L., Digital Fundamentals, 10/e, Pearson Education, 2009.
3	M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007. Harris D. M. and, S. L. Harris, Digital Design and Computer Architecture, 2/e, Morgan Kaufmann Publishers, 2013
4	Tokheim R. L., Digital Electronics Principles and Applications, 7/e, Tata McGraw Hill, 2007.
5	Mano M. M. and M. D Ciletti, Digital Design, 4/e, Pearson Education, 2008.

6	Rajaraman V. and T. Radhakrishnan, An Introduction to Digital Computer Design, 5/e, Prentice Hall India Private Limited, 2012.
7	Samir Palnikar“Verilog HDL: A Guide to Digital Design and Syntheis”, Sunsoft Press

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
100902/EC322T	Logic Circuit Design	To impart an understanding of the basic concepts of Boolean algebra, digital systems which will help them to design and implement different types of practically used sequential circuits using Hardware Description Language.	3rd

COURSE OBJECTIVES:

1	To familiarize students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates (ii)
2	To familiarize students with the HDL based Digital Design Flow.

COURSE OUTCOMES:

Sl. No	**DESCRIPTION**
1	Design and demonstrate the functioning of various combinational and sequential circuits using ICs
2	Apply an industry compatible hardware description language to implement digital circuits
3	Implement digital circuits on FPGA boards and connect external hardware to the boards
4	Function effectively as an individual and in a team to accomplish the given task

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (POs)												Programme-specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3						3			3	3	2	3
2	3	1	1	3	3				3			3	3	2	3
3	3	1	1	3	3				3			3	3	2	3
4	3	3	3		3				3			3	1	2	1
ECL 203	3	2	2	3	3				3			3	**2.5**	**2**	**2.5**

JUSTIFICATION FOR THE CORRELATION LEVEL ASSIGNED IN EACH CELL OF THE TABLE

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO9**	**PO10**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Design & demonstrate the functioning of various combinational and sequential circuits using ICs to solve complex engineering problems.	Analysis of complex Engineering problems by demonstrating functioning of various combinational and sequential circuits	Design solutions for various combinational and sequential circuits using ICs			Helps students function effectively as an individual, and as a member or leader in diverse teams, & in multidisciplinary settings.		Prepare students to engage in independent and life-long learning in the broadest context of technological change.	Helps students to demonstrate their skills in designing and testing of digital circuits	Improves ability of students to apply their knowledge and skills in academic or research career with creativity, commitment and	Demonstrate a sense of professional ethics to carry out their design of various combinational and sequential circuits using ICs .

										social consciousness.	
CO2	Application of industry compatible HDL to implement digital circuits helps to solve complex engineering problems.	Helps to analyze complex Engineering problems reaching substantiated conclusions using engineering science	Design solutions for complex Engineering problems using industry compatible HDL implementation of digital circuits	Application of HDL in the design of exp. and synthesis of information to provide valid conclusions	Create, select, and apply appropriate techniques in HDL to predict and model complex Engineering activities with an understanding of its limitations.	Helps students function effectively as an individual, and as a member or leader in diverse teams, & in multidisciplinary settings.		Prepare students to engage in independent and life-long learning in the broadest context of technological change.	Helps the students to demonstrate their skills in industry compatible hardware description language to implement digital circuits	Improves ability of students to apply their knowledge and skills in industrial, academic or research career with creativity, commitment and social consciousness.	Demonstrate a sense of professional ethics to carry out their professional responsibilities in the field of electronics such as implementing digital circuits using industry compatible HDL.
CO3	Design & Implementation of digital circuits on FPGA boards and	Implementation of digital circuits on FPGA board Helps to Analyze	Design solutions for complex Engineering problems	Application of FPGA boards in	Create, select, and apply appropriate	Helps students function effectively as an individual, and as a		Prepare students to engage in independent and life-long learning in	Improves the ability of students to implem	Improves ability of students to apply their knowle	Helps students to Demonstrate a sense of professional ethics to carry out

	connect external hardware to the boards helps the students to solve complex engineering problems.	complex Engineering problems	using FPGA boards	the design of exp. and synthesis of information to provide valid conclusions	techniques in FPGA to predict and model complex Engineering activities with an understanding of its limitations.	member or leader in diverse teams, & in multidisciplinary settings.		the broadest context of technological change.	ent digital circuits on FPGA boards and connect external hardware to the boards	dge and skills in industrial, academic or research career with creativity, commitment and social consciousness.	their professional responsibilities
CO4	Engineering knowledge helps students to Function effectively as an individual and in a team to accomplish the given task	Analysis of complex Engineering problems help the students to complete the given task	Design solutions for given complex Engineering problems as a team or an individual .		Use of modern tools help the students to create , select and apply techiques to compl	Helps students function effectively as an individual , and as a member or leader in diverse teams, & in multidisciplinary settings.		Prepare students to engage in independent and life-long learning in the broadest context of technological change.	Demonstrate their skills in design , implement and test any digital circuits in a team or an individual	Improves ability of students to apply their knowledge and skills in industrial, academic or research career with creativit	Helps students to Demonstrate a sense of professional ethics to carry out their professional responsibilities to complete any task.

					ete the given task as an individual or team					y, commitment and social consciousness.	

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

Sl No	DESCRIPTION	PROPOSED ACTIONS	PO MAPPING
1	Self starting Counters, Code Converters	Assignment	1,2,3,4,5,9

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

Sl No	DESCRIPTION	PO MAPPING
1	Advanced design level questions solving skills by lab work to have a wider scope of subject beyond syllabus.	1,2,3,4,5

WEB SOURCE REFERENCES:

1	http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/digital_circuit/frame/
2	http://www.electronics-tutorials.ws/logic/logic_1.html

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☐ CHALK & TALK	☐ STUD. ASSIGNMENT	☐ WEB RESOURCES	
☐LCD/SMART BOARDS	☐STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS	☐STUD. SEMINARS	☐ TESTS/MODEL EXAMS	☐ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☐ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☐ STUDENT FEEDBACK ON FACULTY
☐ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

Prepared by | **Approved by**

Dr. Sabna N | Dr. Rithu James

Mr. Rony Antony P | (HoD)

Ms. Anila Kuriakose

COURSE PLAN

Unit	Details	Hrs
	It is compulsory to conduct a minimum of 5 experiments from Part A and a minimum of 5 experiments from Part B.	
	Part A (Any 5)	
	The following experiments can be conducted on breadboard or trainer kits.	
1	Realization of functions using basic and universal gates (SOP and POS forms).	3 hr.
2	Design and Realization of half /full adder and subtractor using basic gates and universal gates.	3 hr.
3	4-bit adder/subtractor and BCD adder using 7483.	3 hr.
4	Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.	3 hr.
5	Asynchronous Counter:3 bit up/down counter	3 hr.
6	Asynchronous Counter: Realization of Mod N counter	3 hr.
7	Synchronous Counter: Realization of 4-bit up/down counter.	3 hr.
8	Synchronous Counter: Realization of Mod-N counters.	3 hr.
9	Ring counter and Johnson Counter. (Using FF & 7495).	3 hr.
10	Realization of counters using IC's (7490, 7492, 7493).	3 hr.
11	Multiplexers and De-multiplexers using gates and ICs. (74150, 74154)	3 hr.
12	Realization of combinational circuits using MUX & DEMUX.	3 hr.
13	Random Sequence generator using LFSR.	3 hr.
	PART B (Any 5)	

The following experiments aim at training the students in digital circuit design with verilog and implementation in small FPGAs. Small, low cost FPGAs, that can be driven by open tools for simulation, synthesis and place and route, such as *TinyFPGA* or *Lattice iCEstick* can be used. Open software tools such as *yosis* (for simulation and synthesis) and *arachne* (for place and route) may be used. The experiments will lay the foundation for digital design with FPGA with the objective of increased employability.

1	Experiment 1. Realization of Logic Gates and Familiarization of FPGAs	3 hr.
	(a) Familiarization of a small FPGA bboard and its ports and interface.	
	(b) Create the .pcf files for your FPGA board.	
	(c) Familiarization of the basic syntax of Verilog	
	(d) Development of verilog modules for basic gates, synthesis and implementation in the above FPGA to verify the truth tables.	
	(e) Verify the universality and non associativity of NAND and NOR gates by uploading the corresponding verilog files to the FPGA boards.	
2	Experiement 2: Adders in Verilog	3 hr.
	(a) Development of verilog modules for half adder in 3 modeling styles (dataflow/structural/	
	behavioural).	
	(b) Development of verilog modules for full adder in structural modeling using half adder.	
3	Experiement 3: Mux and Demux in Verilog	
	(a) Development of verilog modules for a 4x1 MUX.	
	(b) Development of verilog modules for a 1x4 DEMUX.	
4	Experiement 4: Flipflops and coutners	3 hr.
	(a) Development of verilog modules for SR, JK and D flipflops.	

	(b) Development of verilog modules for a binary decade/Johnson/Ring counters	
5	Experiment 5. Multiplexer and Logic Implementation in FPGA	3 hr.
	(a) Make a gate level design of an 8 : 1 multiplexer, write to FPGA and test its functionality.	
	(b) Use the above module to realize the logic function f (A, B, C) = ∑m(0, 1, 3, 7) and test it.	
	(c) Use the same 8 : 1 multiplexer to realize the logic function f (A, B, C, D) = ∑m(0, 1, 3, 7, 10, 12) by partitioning the truth table properly and test it.	
6	Experiment 6. Flip-Flops and their Conversion in FPGA	3 hr.
	(a) Make gate level designs of J-K, J-K master-slave, T and D flip-flops, implement and test them on the FPGA board.	
	(b) Implement and test the conversions such as T to D, D to T, J-K to T and J-K to D in FPGA	
7	Experiment 7: Asynchronous and Synchronous Counters	3 hr.
	(a) Make a design of a 4-bit up down ripple counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board.	
	(b) Make a design of a 4-bit up down synchronous counter using T-flip-lops in the previous experiment, implement and test them on the FPGAboard.	
8	Experiment 8: Universal Shift Register in FPGA	3 hr.
	(a) Make a design of a 4-bit universal shift register using D-flip-flops in the previous	
	experiment, implement and test them on the FPGA board.	
	(b) Implement ring and Johnson counters with it.	
9	Experiment 9. BCD to Seven Segment Decoder in FPGA	3 hr.
	(a) Make a gate level design of a seven segment decoder, write to FPGA and test its	
	functionality.	

	(b) Test it with switches and seven segment display. Use ouput ports for connection to the display.	