

MATHEMATICS – Third Semester B. Tech

(For all branches except Computer Science and Information Technology)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT201	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS	BASIC SCIENCE COURSE	3	1	0	4

Preamble: This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. To understand the basic theory of functions of a complex variable, residue integration and conformal transformation.

Prerequisite: A basic course in partial differentiation and complex numbers.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the concept and the solution of partial differential equation.
CO 2	Analyse and solve one dimensional wave equation and heat equation.
CO 3	Understand complex functions, its continuity differentiability with the use of Cauchy-Riemann equations.
CO 4	Evaluate complex integrals using Cauchy’s integral theorem and Cauchy’s integral formula, understand the series expansion of analytic function
CO 5	Understand the series expansion of complex function about a singularity and Apply residue theorem to compute several kinds of real integrals.

Mapping of course outcomes with program outcomes

PO’s	Broad area
PO 1	Engineering Knowledge
PO 2	Problem Analysis
PO 3	Design/Development of solutions
PO 4	Conduct investigations of complex problems
PO 5	Modern tool usage
PO 6	The Engineer and Society
PO 7	Environment and Sustainability
PO 8	Ethics
PO 9	Individual and team work

PO 10	Communication
PO 11	Project Management and Finance
PO 12	Life long learning

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(%)		End Semester Examination(%)
	1	2	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Form the partial differential equation given $z = xf(x) + ye^2$
2. What is the difference between complete integral and singular integral of a partial differential equation
3. Solve $3z = xp + yq$
4. Solve $(p^2 + q^2)y = qz$
5. Solve $u_x - 2u_t = u$ by the method of separation of variables

Course Outcome 2 (CO2):

1. Write any three assumptions in deriving one dimensional wave equations
2. Derive one Dimensional heat equation
3. Obtain a general solution for the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$
4. A tightly stretched flexible string has its ends fixed at $x = 0$ and $x = l$. At $t = 0$, the string is given a shape defined by $f(x) = \mu x(l - x)$ where μ is a constant
5. Find the temperature $u(x, t)$ in a bar which is perfectly insulated laterally whose ends are kept at $0^\circ C$ and whose initial temperature (in degree Celsius) is $f(x) = x(10 - x)$ given that its length is 10 cm and specific heat is 0.056 cal/gram deg

Course Outcome 3(CO3):

1. Separate the real and imaginary parts of $f(z) = \frac{1}{1+z}$
2. Check whether the function $f(z) = \frac{Re(z^2)}{|z|}$ is continuous at $z = 0$ given $f(0) = 0$
3. Determine a and b so that function $u = e^{-\pi x} \cos y$ is harmonic. Find its harmonic conjugate.
4. Find the fixed points of $w = \frac{i}{2z-1}$
5. Find the image of $|z| \leq \frac{1}{2}$, $-\frac{\pi}{8} < \arg z < \frac{\pi}{8}$ under $w = z^2$

Course Outcome 4(CO4):

1. Find the value of $\int_C \exp(z^2) dz$ where C is $|z| = 1$
2. Integrate the function $\int_C \frac{\sin z}{z+4iz} dz$ where C is $|z - 4 - 2i| = 6.5$
3. Evaluate $\int_C \frac{e^z}{(z-\frac{\pi}{4})^3} dz$ where C is $|z| = 1$
4. Find the Maclaurin series expansion of $f(z) = \frac{i}{1-z}$ and state the region of convergence.
5. Find the image of $|z| = 2$ under the mapping $w = z + \frac{1}{z}$

Course Outcome 5 (CO5):

1. Determine the singularity of $\exp\left(\frac{1}{z}\right)$
2. Find the Laurent series of $\frac{1}{z^2(z-i)}$ about $z = i$
3. Find the residues of $f(z) = \frac{50z}{z^3 + 2z^2 - 7z + 4}$
4. Evaluate $\int_C \tan 2\pi z dz$ where C is $|z - 0.2| = 0.2$
5. Evaluate $\int_0^{2\pi} \frac{d\theta}{\sqrt{2-\cos \theta}}$

Syllabus

Module 1 (Partial Differential Equations) (8 hours)

(Text 1-Relevant portions of sections 17.1, 17.2, 17.3, 17.4, 17.5, 17.7, 18.1, 18.2)

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’s linear equation, Non-linear equations of the first order -Charpit’s method, Solution of equation by method of separation of variables.

Module 2 (Applications of Partial Differential Equations) (10 hours)

(Text 1-Relevant portions of sections 18.3,18.4, 18.5)

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

Module 3 (Complex Variable – Differentiation) (9 hours)

(Text 2: Relevant portions of sections13.3, 13.4, 17.1, 17.2 , 17.4)

Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, Conformal mappings- mappings $w = z^2$, $w = e^z$,. Linear fractional transformation $w = \frac{1}{z}$, fixed points, Transformation $w = \sin z$

(From sections 17.1, 17.2 and 17.4 only mappings $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$ and problems based on these transformation need to be discussed)

Module 4 (Complex Variable – Integration) (9 hours)

(Text 2- Relevant topics from sections14.1, 14.2, 14.3, 14.4,15.4)

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 representation of a path, Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, Cauchy integral theorem (without proof) on multiply connected domain Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function, Taylor’s series and Maclaurin series.,

Module 5 (Complex Variable – Residue Integration) (9 hours)

(Text 2- Relevant topics from sections16.1, 16.2, 16.3, 16.4)

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, Residue integration of real integrals – integrals of rational functions of $\cos\theta$ and $\sin\theta$, integrals of improper integrals of the form

$\int_{-\infty}^{\infty} f(x) dx$ with no poles on the real axis. ($\int_A^B f(x) dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus),

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

References:

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012

Assignments

Assignment: Assignment must include applications of the above theory in the concerned engineering branches

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Partial Differential Equations	
1.1	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,	3
1.2	Linear equations of the first order- Lagrange’s linear equation, Non-linear equations of the first order - Charpit’s method	3
1.3	Boundary value problems, Method of separation of variables.	2
2	Applications of Partial Differential Equations	
2.1	One dimensional wave equation- vibrations of a stretched string, derivation,	1
2.2	Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D’Alembert’s solution of the wave equation	4
2.3	One dimensional heat equation, derivation,	1
2.4	Solution of the heat equation, using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation	4

3	Complex Variable – Differentiation	
3.1	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations,	4
3.2	harmonic functions, finding harmonic conjugate,	2
3.3	Conformal mappings- mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$.	3
4	Complex Variable – Integration	
4.1	Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method, second evaluation method, use of representation of a path	4
4.2	Contour integrals, Cauchy integral theorem (without proof) on simply connected domain, on multiply connected domain(without proof). Cauchy Integral formula (without proof),	2
4.3	Cauchy Integral formula for derivatives of an analytic function,	2
4.3	Taylor's series and Maclaurin series.	1
5	Complex Variable – Residue Integration	
5.1	Laurent's series(without proof)	2
5.2	zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues,	2
5.3	Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem	2
5.4	Residue integration of real integrals – integrals of rational functions of $\cos\theta$ and $\sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$ with no poles on the real axis. ($\int_A^B f(x)dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus),	3

Model Question Paper

(For all branches except Computer Science and Information Technology)

(2019 Scheme)

Reg No:

Name:

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH. DEGREE EXAMINATION
(MONTH & YEAR)

Course Code:

Course Name: PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS

MAX.MARKS: 100

DURATION: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1. Derive a partial differential equation from the relation $z = f(x + at) + g(x - at)$
2. Solve $\frac{\partial^2 z}{\partial x \partial y} = x^2 y$
3. State any three assumptions in deriving the one dimensional wave equation
4. What are the possible solutions of one-dimensional heat equation?
5. If $f(z) = u + iv$ is analytic, then show that u and v are harmonic functions.
6. Check whether $f(z) = \bar{z}$ is analytic or not.
7. Evaluate $\int_c \tan z \, dz$ where c is the unit circle.
8. Find the Taylor's series of $f(z) = \frac{1}{z}$ about $z = 2$.
9. What type of singularity have the function $f(z) = \frac{1}{\cos z - \sin z}$
10. Find the residue of $\frac{e^z}{z^3}$ at its pole.

PART B

Answer any one full question from each module, each question carries 14 marks.

Module-I

11. (a) Solve $x(y - z)p + y(z - x)q = z(x - y)$
(b) Use Charpit's methods to solve $q + xp = p^2$
12. (a) Find the differential equation of all spheres of fixed radius having their centers in the xy -plane.

- (b) Using the method of separation of variables, solve $\frac{\partial u}{\partial x} = 2 \frac{\partial u}{\partial t} + u$, where $u(x, 0) = 6e^{-3x}$.

Module – II

13. (a) Derive the solution of one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$ with zero boundary conditions and with initial conditions $u(x, 0) = f(x)$ and $\left(\frac{\partial u}{\partial t}\right)_{t=0} = 0$.
- (b) A homogeneous rod of conducting material of length 100 cm has its ends kept at zero temperature and the temperature initially is $u(x, 0) = \begin{cases} x, & 0 \leq x \leq 50 \\ 100 - x, & 50 \leq x \leq 100 \end{cases}$. Find the temperature $u(x, t)$ at any time.
14. (a) A tightly stretched string of length l with fixed ends is initially in equilibrium position. It is set vibrating by giving each point a velocity $v_0 \sin^3\left(\frac{\pi x}{l}\right)$. Find the displacement of the string at any time.
- (b) An insulated rod of length l has its ends A and B are maintained at 0°C and 100°C respectively under steady state condition prevails. If the temperature at B is suddenly reduced to 0°C and maintained at 0°C , Find the temperature at a distance x from A at time t .

Module-III

15. (a) Show that $f(z) = e^z$ is analytic for all z . Find its derivative.
- (b) Find the image of $|z - 2i| = 2$ under the transformation $w = \frac{1}{z}$
16. (a) Prove that the function $u(x, y) = x^3 - 3xy^2 - 5y$ is harmonic everywhere. Find its harmonic conjugate.
- (b) Find the image of the infinite stripe $0 \leq y \leq \pi$ under the transformation $w = e^z$

Module-IV

17. (a) Evaluate $\int_0^{2+i} (\bar{z})^2 dz$, along the real axis to 2 and then vertically to $2 + i$
- (b) Using Cauchy's integral formula evaluate $\int_c \frac{5z+7}{z^2+2z-3} dz$, where c is $|z - 2| = 2$
18. (a) Evaluate $\int_c \frac{\sin^2 z}{\left(z - \frac{\pi}{6}\right)^3} dz$, where C is $|z| = 1$.
- (b) Expand $\frac{1}{(z-1)(z-2)}$ in the region $|z| < 1$

Module- V

19. (a) Expand $f(z) = \frac{z^2-1}{z^2-5z+6}$ in $2 < |z| < 3$ as a Laurent's series.
- (b) Using contour integration evaluate $\int_0^{2\pi} \frac{d\theta}{2+\cos \theta}$
20. (a) Use residue theorem to evaluate $\int_c \frac{\cos h \pi z}{z^2+4} dz$ where c is $|z| = 3$.
- (b) Apply calculus of residues to evaluate $\int_{-\infty}^{\infty} \frac{1}{(x^2+1)^3} dx$.

ECT201	SOLID STATE DEVICES	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to understand the physics and working of solid state devices.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply Fermi-Dirac Distribution function and Compute carrier concentration at equilibrium and the parameters associated with generation, recombination and transport mechanism
CO 2	Explain drift and diffusion currents in extrinsic semiconductors and Compute current density due to these effects.
CO 3	Define the current components and derive the current equation in a pn junction diode and bipolar junction transistor.
CO 4	Explain the basic MOS physics and derive the expressions for drain current in linear and saturation regions.
CO 5	Discuss scaling of MOSFETs and short channel effects.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Compute carrier concentration at equilibrium and the parameters associated with generation, recombination and transport mechanism

1. Derive the expression for equilibrium electron and hole concentration.
2. Explain the different recombination mechanisms
3. Solve numerical problems related to carrier concentrations at equilibrium, energy band diagrams and excess carrier concentrations in semiconductors.

Course Outcome 2 (CO2) : Compute current density in extrinsic semiconductors in specified electric field and due to concentration gradient.

1. Derive the expression for the current density in a semiconductor in response to the applied electric field.
2. Derive the expression for diffusion current in semiconductors.
3. Show that diffusion length is the average distance a carrier can diffuse before recombining.

Course Outcome 3 (CO3): Define the current components and derive the current equation in a pn junction diode and bipolar junction transistor.

1. Derive ideal diode equation.
2. Derive the expression for minority carrier distribution and terminal currents in a BJT.

3. Solve numerical problems related to PN junction diode and BJT.

Course Outcome 4 (CO4): Explain the basic MOS physics with specific reference on MOSFET characteristics and current derivation.

1. Illustrate the working of a MOS capacitor in the three different regions of operation.
2. Explain the working of MOSFET and derive the expression for drain current.
3. Solve numerical problems related to currents and parameters associated with MOSFETs.

Course Outcome 5 (CO5): Discuss the concepts of scaling and short channel effects of MOSFET.

1. Explain the different MOSFET scaling techniques.
2. Explain the short channel effects associated with reduction in size of MOSFET.

SYLLABUS

MODULE I

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 II

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 III

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 IV

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 V

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 Books

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

Reference Books

1. Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012
2. Sze S.M., Semiconductor Devices: Physics and Technology, John Wiley, 3/e, 2005
3. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
4. Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005
5. Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill, 2015
6. Yannis Tzividis, Operation and Modelling of the MOS Transistor, Oxford University Press.
7. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	MODULE 1	
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,	2

	variation of mobility with temperature and doping.	
2.2	Diffusion equation	1
2.3	Einstein relations, Poisson equations	1
2.4	Poisson equations, 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

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

ECT 201 SOLID STATE DEVICES

Time: 3 hours

Max. Marks:100

PART A

Answer **all** questions. Each question carries **3 marks**.

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

Estd.

Answer **any one** question from each module. Each question carries 14 marks.

MODULE I

11. (a) Derive law of mass action. (8 marks)
 (b) An n-type Si sample with $N_d = 10^{15} \text{ cm}^{-3}$ is steadily illuminated such that $g_{op} = 10^{21} \text{ EHP/cm}^3 \text{ s}$. If $\tau_n = \tau_p = 1 \mu\text{s}$ for this excitation. Calculate the separation in the Quasi-Fermi levels ($F_n - F_p$). Draw the Energy band diagram.. (6 marks)
12. (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 $N_C = 3.22 \times 10^{19} \text{ cm}^{-3}$ and $N_V = 1.83 \times 10^{19} \text{ cm}^{-3}$. Determine (a) the electron and hole concentrations at 300K
 (b) the intrinsic carrier concentration at 400 K. (6 marks)

MODULE II

13. (a) Derive the expression for mobility, conductivity and Drift current density in a semiconductor. (8 marks)
- (b) A Si bar $0.1 \mu\text{m}$ long and $100 \mu\text{m}^2$ in cross-sectional area is doped with 10^{17}cm^{-3} phosphorus. Find the current at 300 K with 10 V applied. (b). How long will it take an average electron to drift $1 \mu\text{m}$ in pure Si at an electric field of 100V/cm ? (6 marks)
14. (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 $\mu_n = 8500 \text{cm}^2/\text{Vs}$, $\mu_p = 400 \text{cm}^2/\text{Vs}$, $n_i = 1.79 \times 10^6 \text{cm}^{-3}$. (7 marks)
- (b) Derive the steady-state diffusion equations in semiconductors. (6 marks)

MODULE III

15. (a) Derive the expression for ideal diode equation. State the assumptions used. (9 marks)
- (b) Boron is implanted into an n-type Si sample ($N_d = 10^{16} \text{cm}^{-3}$), forming an abrupt junction of square cross section with area $= 2 \times 10^{-3} \text{cm}^2$. Assume that the acceptor concentration in the p-type region is $N_a = 4 \times 10^{18} \text{cm}^{-3}$. Calculate V_0 , W , Q^+ , and E_0 for this junction at equilibrium (300 K). (5 marks)
16. 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

17. (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 (SiO_2) on p-type Si with $N_a = 10^{16} \text{cm}^{-3}$. (b) Include the effects of flat band voltage, assuming an n + polysilicon gate and fixed oxide charge of $5 \times 10^{10} \text{q} (\text{C}/\text{cm}^2)$. (6 marks)
18. (a) Explain the CV characteristics of an ideal MOS capacitor (8 Marks)
- (b) For a long channel n-MOSFET with $W = 1\text{V}$, calculate the V_G required for an $I_{D(\text{sat.})}$ of 0.1 mA and $V_{D(\text{sat.})}$ of 5V. Calculate the small-signal output conductance g and V the transconductance $g_{m(\text{sat.})}$ at $V_D = 10\text{V}$. Recalculate the new I_D for $(V_G - V_T) = 3$ and $V_D = 4\text{V}$. (6 marks)

MODULE V

19. Explain Drain induced barrier lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects associated with scaling down of MOSFETs (14 marks)
20. With the aid of suitable diagrams explain the structure and working of a FINFET. List its advantages (14 marks)

ECT 203	LOGIC CIRCUIT DESIGN	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to impart the basic knowledge of logic circuits and enable students to apply it to design a digital system.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Course project	: 15 marks

It is mandatory that a *course project* shall be undertaken by a student for this subject. The course project can be performed either as a hardware realization/simulation of a typical digital system using combinational or sequential logic. Instead of two assignments, two evaluations may be performed on the course project along with series tests, each carrying 5 marks. Upon successful completion of the project, a brief report shall be submitted by the student which shall be evaluated for 5 marks. The report has to be submitted for academic auditing. A few samples projects are given below:

Sample course projects:

1. M-Sequence Generator Pseudo random sequences are popularly used in wireless communication. A sequence generator is used to produce pseudo-random codes that are useful in spread spectrum applications. Their generation relies on irreducible polynomials. A maximal length sequence generator that relies on the polynomial $P(D) = D^7 + D^3 + 1$, with each D represent delay of one clock cycle.

- An 8-bit shift register that is configured as a ring counter may be used realize the above equation.
- This circuit can be developed in verilog, simulated, synthesized and programmed into a tiny FPGA and tested in real time.
- Observe the M-sequence from parallel outputs of shift register for one period . Count the number of 1s and zeros in one cycle.
- Count the number of runs of 1s in singles, pairs, quads etc. in the pattern.

2. BCD Subtractor

- Make 4 -bit parallel adder circuit in verilog.
- Make a one digit BCD subtracter in Verilog, synthesize and write into a tiny FPGA.
- Test the circuit with BCD inputs.

3. Digital Thermometer

- Develop a circuit with a temperature sensor and discrete components to measure and display temperature.
- Solder the circuit on PCB and test it.

4. Electronic Display

- This display should receive the input from an alphanumeric keyboard and display it on an LCD display.
- The decoder and digital circuitry is to developed in Verilog and programmed into a tiny FPGA.

5. Electronic Roulette Wheel

- 32 LEDs are placed in a circle and numbered that resembles a roulette wheel.
- A 32-bit shift register generates a random bit pattern with a single 1 in it.
- When a push button is pressed the single 1 lights one LED randomly.
- Develop the shift register random pattern generator in verilog and implement on a tiny FPGA and test the circuit.

6. Three Bit Carry Look Ahead Adder

- Design the circuit of a three bit carry look ahead adder.
- Develop the verilog code for it and implement and test it on a tiny FPGA. item Compare the performance with a parallel adder.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. The questions on verlog modelling should not have a credit more than 25% of the whole mark.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Number Systems and Codes

1. Consider the signed binary numbers $A = 01000110$ and $B = 11010011$ where B is in 2's complement form. Find the value of the following mathematical expression (i) $A + B$ (ii) $A - B$
2. Perform the following operations (i) $D9CE_{16} - CFDA_{16}$ (ii) $6575_8 - 5732_8$
3. Convert decimal 6,514 to both BCD and ASCII codes. For ASCII, an even parity bit is to be appended at the left.

Course Outcome 2 (CO2) : Boolean Postulates and combinational circuits

1. Design a magnitude comparator to compare two 2-bit numbers $A = A_1A_0$ and $B = B_1B_0$
2. Simplify using K-map $F(a,b,c,d) = \sum m(4,5,7,8,9,11,12,13,15)$
3. Explain the operation of a 8x1 multiplexer and implement the following using an 8x1 multiplexer $F(A, B, C, D) = \sum m(0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14)$

Course Outcome 3 (CO3) : Logic families and its characteristics

1. Define the terms noise margin, propagation delay and power dissipation of logic families. Compare TTL and CMOS logic families showing the values of above mentioned terms.
2. Draw the circuit and explain the operation of a TTL NAND gate
3. Compare TTL, CMOS logic families in terms of fan-in, fan-out and supply voltage

Course Outcome 4 (CO4) : Sequential Logic Circuits

1. Realize a T flip-flop using NAND gates and explain the operation with truth table, excitation table and characteristic equation
2. Explain a MOD 6 asynchronous counter using JK Flip Flop
3. Draw the logic diagram of 3 bit PIPO shift register with LOAD/SHIFT control and explain its working

Course Outcome 5 (CO5) : Logic Circuit Design using HDL

1. Design a 4-to-1 mux using gate level Verilog model.
2. Design a verilog model for a half adder circuit. Make a one bit full adder by connecting two half adder models.
3. Compare concurrent signal assignment versus sequential signal assignment.

Syllabus

Module 1: Number Systems and Codes:

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.

Module 2: Boolean Postulates and Fundamental Gates

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.

Module 3: Combinatorial and Arithmetic Circuits

Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. Modeling and simulation of combinatorial circuits with verilog codes at the gate level.

Module 4: Sequential Logic Circuits:

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.

Module 5: Logic families and its characteristics:

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.

Text Books

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 Synthesis", Sunsoft Press
5. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009

Reference Books

1. W.H. Gothmann, "Digital Electronics – An introduction to theory and practice", PHI, 2nd edition, 2006
2. Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008
3. A. Ananthakumar, "Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016
4. Fletcher, William I., An Engineering Approach to Digital Design, 1st Edition, Prentice Hall India, 1980

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Number Systems and Codes:	
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:	
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	
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:	
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,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:	
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



Simulation Assignments (ECT203)

The following simulations can be done in QUCS, KiCad or PSPICE.

BCD Adder

- Realize a one bit parallel adder, simulate and test it.
- Cascade four such adders to form a four bit parallel adder.
- Simulate it and make it into a subcircuit.
- Develop a one digit BCD adder, based on the subcircuit, simulate and test it

BCD Subtractor

- Use the above 4 -bit adder subcircuit, implement and simulate a one digit BCD subtractor.
- Test it with two BCD inputs

Logic Implementation with Multiplexer

- Develop an 8 : 1 multiplexer using gates, simulate, test and make it into a subcircuit.
- Use this subcircuit to implement the logic function $f(A, B, C) = \sum m(1, 3, 7)$
- Modify the truth table properly and implement the logic function $f(A, B, C, D) = \sum m(1, 4, 12, 14)$ using one 8 : 1 multiplexer.

BCD to Seven Segment Decoder

- Develop a BCD to seven segment decoder using gates and make it into a subcircuit.
- simulate this and test it

Ripple Counters

- Understand the internal circuit of 7490 IC and develop it in the simulator.
- Make it into a subcircuit and simulate it. Observe the truth table and timing diagrams for mod-5, mod-2 and mod-10 operation.
- Develop a mod-40 (mod-8 and mod-5) counter by cascading two such subcircuits.
- Simulate and observe the timing diagram and truth table.

Synchronous Counters

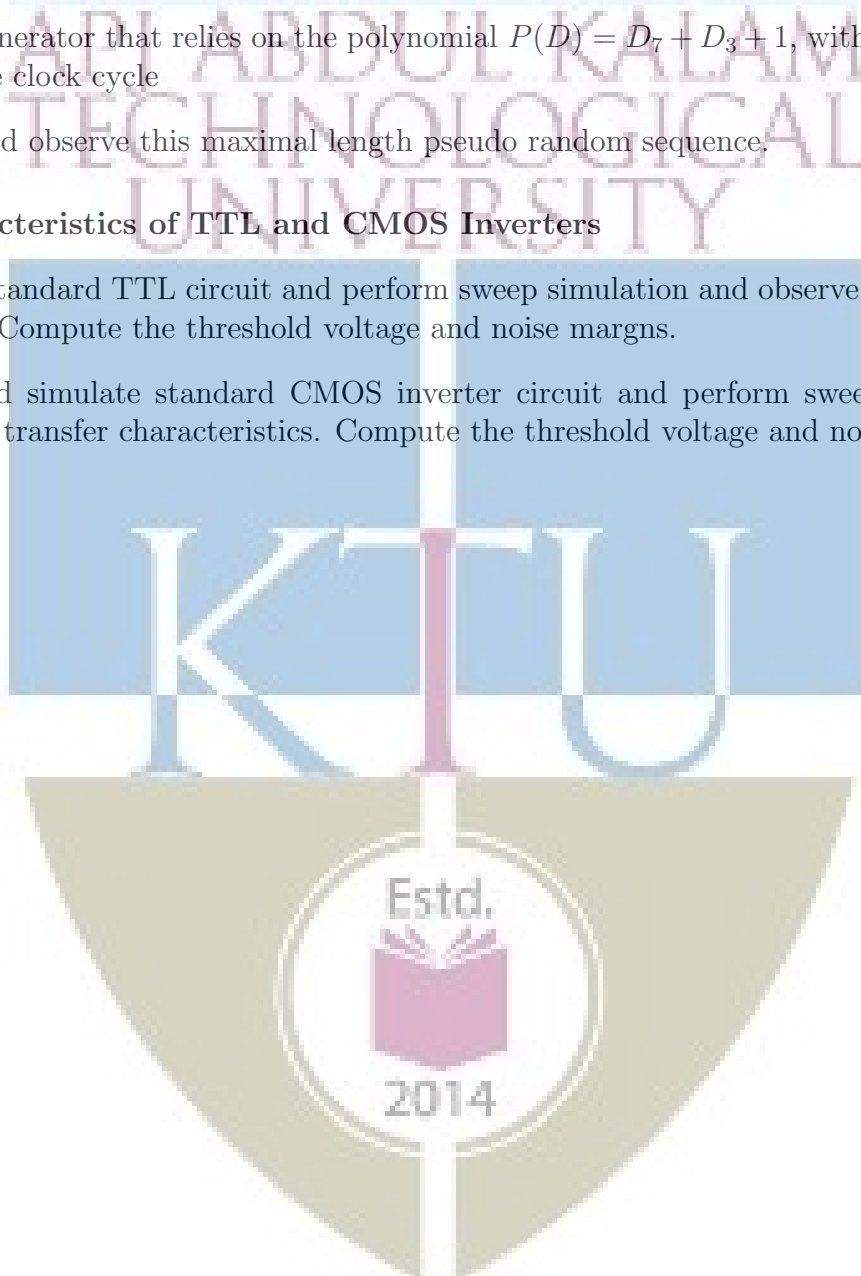
- Design and develop a 4-bit synchronous counter using J-K flip-flops.
- Perform digital simulation and observe the timing diagram and truth table.

Sequence Generator

- Connect D flip-flops to realize an 8-bit shift register and make it into a subcircuit.
- sequence generator that relies on the polynomial $P(D) = D^7 + D^3 + 1$, with each D representing a delay of one clock cycle
- Simulate and observe this maximal length pseudo random sequence.

Transfer Characteristics of TTL and CMOS Inverters

- Develop a standard TTL circuit and perform sweep simulation and observe the transfer characteristics. Compute the threshold voltage and noise margins.
- Develop and simulate standard CMOS inverter circuit and perform sweep simulation and observe the transfer characteristics. Compute the threshold voltage and noise margins.



Model Question Paper

A P J Abdul Kalam Technological University

Third Semester B Tech Degree Examination

Branch: Electronics and Communication

Course: ECT 203 Logic Circuit Design

Time: 3 Hrs

Max. Marks: 100

PART A

Answer All Questions

- 1 Convert 203.52_{10} to binary and hexadecimal. (3) K_1
- 2 Compare bitwise and logical verilog operators (3) K_1
- 3 Prove that NAND and NOR are not associative. (3) K_2
- 4 Convert the expression $ABCD+ABC\bar{C}+ACD$ to minterms. (3) K_2
- 5 Define expressions in Verilog with example. (3) K_2
- 6 Explain the working of a decoder. (3) K_1
- 7 What is race around condition? (3) K_1
- 8 Convert a T flip-flop to D flip-flop. (3) K_2
- 9 Define fan-in and fan-out of logic circuits. (3) K_2
- 10 Define noise margin and how can you calculate it? (3) K_2

PART B

Answer one question from each module. Each question carries 14 mark.

2014

Module I

- 11(A) Subtract 46_{10} from 100_{10} using 2's complement arithmetic. (8) K_2
- 11(B) Give a brief description on keywords and identifiers in Verilog with example. (6) K_2

OR

- 12(A) Explain the floating and fixed point representation of numbers (8) K_2
 12(A) Explain the differences between programming languages and HDLs (6) K_2

Module II

- 13(A) Simplify using K-map (7) K_3

$$f(A, B, C, D) = \sum m(4, 5, 7, 8, 9, 11, 12, 13, 15)$$

- using K-maps
 13(B) Write a Verilog code for implementing above function (7) K_3

OR

- 14(A) Write a Verilog code to implement the basic gates. (7) K_3

- 14(B) Reduce the following Boolean function using K-Map and implement the simplified function using the logic gates (7) K_3

$$f(A, B, C, D) = \sum (0, 1, 4, 5, 6, 8, 9, 10, 12, 13, 14)$$

Module III
Estd.

- 15(A) Design a 3-bit magnitude comparator circuit. (8) K_3

- 15(B) Write a Verilog description for a one bit full adder circuit. (6) K_3

OR

- 16(A) Write a verilog code to implement 4:1 multiplexer (6) K_3

- 16(B) Implement the logic function (8) K_3

$$f(A, B, C) = \sum m(0, 1, 4, 7)$$

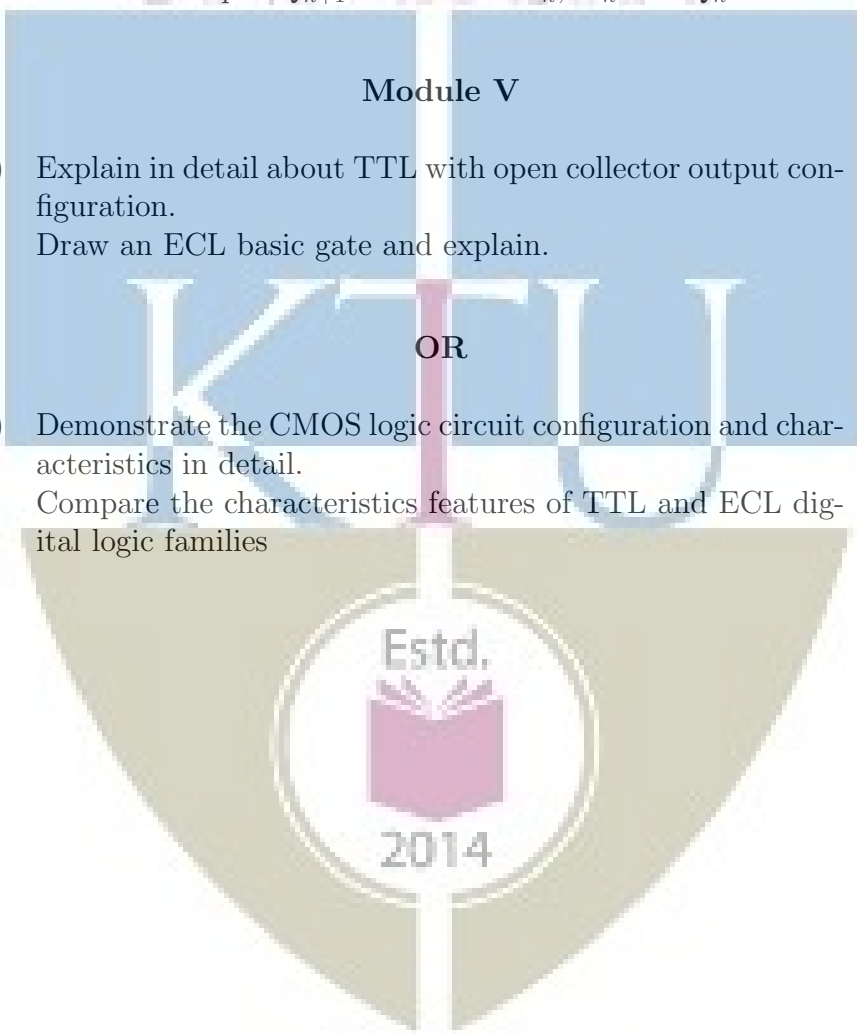
using 8 : 1 and 4 : 1 multiplexers.

Module IV

- 17 Design MOD 12 asynchronous counter using T flip-flop. (14) K_3
- OR**
- 18(A) Explain the operation of Master Slave JK flipflop. (7) K_3
- 18(B) Derive the output Q_{n+1} in Terms of J_n , K_n and Q_n (7) K_3

Module V

- 19(A) Explain in detail about TTL with open collector output configuration. (8) K_2
- 19(B) Draw an ECL basic gate and explain. (6) K_2
- OR**
- 20(A) Demonstrate the CMOS logic circuit configuration and characteristics in detail. (8) K_2
- 20(B) Compare the characteristics features of TTL and ECL digital logic families (6) K_2



ECT205	NETWORK THEORY	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to analyze the linear time invariant electronic circuits.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

MAT102 Vector Calculus, Differential Equations and Transforms (Laplace Transform)

Course Outcomes: After the completion of the course the student will be able to

CO 1 K3	Apply Mesh / Node analysis or Network Theorems to obtain steady state response of the linear time invariant networks.
CO 2 K3	Apply Laplace Transforms to determine the transient behaviour of RLC networks.
CO 3 K3	Apply Network functions and Network Parameters to analyse the single port and two port networks.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Obtain steady state response of the network using Mesh / Node analysis. (K3)

1. Enumerate different types of sources in electronic networks.
2. Solve networks containing independent and dependent sources using Mesh / Node analysis.
3. Evolve the steady-state AC analysis of a given network using Mesh or Node analysis.

Course Outcome 1 (CO1) : Obtain steady state response of the network using Network Theorems. (K3)

1. Determine the branch current of the given network with dependent source using superposition theorem.
2. State and prove Maximum Power Transfer theorem.
3. Find the Thevenin's / Norton's equivalent circuit across the port of a given network having dependent source.

Course Outcome 2 (CO2): Determine the transient behaviour of network using Laplace Transforms (K3)

1. The switch is opened at $t = 0$ after steady state is achieved in given network. Find the expression for the transient output current.
2. Find the Laplace Transform of a given waveform.
3. In the given circuit, the switch is closed at $t = 0$, connecting an energy source to the R,C,L circuit. At time $t = 0$, it is observed that capacitor voltage has a initial value. For the element values given, determine expression for output voltage after converting the circuit into transformed domain.

Course Outcome 3 (CO3): Apply Network functions to analyse the single port and two port network. (K3)

1. What are the necessary conditions for a network Driving point function and Transfer functions?
2. Evaluate the Driving point function and Transfer function for the given network,
3. Plot the poles and zeros of the given network.

Course Outcome 3 (CO3): Apply Network Parameters to analyse the two port network. (K3)

1. Deduce the transmission parameters of two port network in terms of two port network parameters.
2. Define the condition for a two port network to be reciprocal.
3. Two identical sections of the given networks are connected in parallel. Obtain the two port network parameters of the combination.

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 network. 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).

Text Books

1. Valkenburg V., "Network Analysis", Pearson, 3/e, 2019.
2. Sudhakar A, Shyammoohan S. P., "Circuits and Networks- Analysis and Synthesis", McGraw Hill, 5/e, 2015.

Reference Books

1. Edminister, "Electric Circuits – Schaum's Outline Series", McGraw-Hill, 2009.
2. W. Hayt, J. Kemmerly, J. Phillips, S. Durbin, "Engineering Circuit Analysis," McGraw Hill.
2. K. S. Suresh Kumar, "Electric Circuits and Networks", Pearson, 2008.
3. William D. Stanley, "Network Analysis with Applications", 4/e, Pearson, 2006.
4. Ravish R., "Network Analysis and Synthesis", 2/e, McGraw-Hill, 2015.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Mesh and Node Analysis	
1.1	Review of circuit elements and Kirchoff'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 network	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

Simulation Assignments:

Atleast one assignment should be simulation of steady state and transient analysis of R, L, C circuits with different types of energy sources on any circuit simulation software. Samples of simulation assignments are listed below. The following simulations can be done in QUCS, KiCad or PSPICE.

1. Make an analytical solution of Problem 4.3 in page 113 of the book *Network Analysis* by M E Van Valkenberg. Realize this circuit in the simulator and observe $i(t)$ and $V_2(t)$ using transient simulation.
2. Realize a series RLC circuit with
 - $R = 200\Omega$, $L = 0.1H$, $C = 13.33\mu F$
 - $R = 200\Omega$, $L = 0.1H$, $C = 10\mu F$ and
 - $R = 200\Omega$, $L = 0.1H$, $C = 1\mu F$ and no source respectively. The initial voltage across the capacitor is 200V Simulate the three circuits, and observe the current $i(t)$ through them.
3. Repeat the above assignment for the three set of component values for a parallel RLC circuit.
4. Refer Problem 9.18 in page 208 in the book *Electric Circuits* by Nahvi and Edminister 4th Edition. See Fig. 9.28. Simulate this circuit to verify superposition theorem for the three current with individual sources and combination.
5. Refer Problem 9.22 in page 210 in the book *Electric Circuits* by Nahvi and Edminister 4th Edition. See Fig. 9.32. Implement the circuit on the simulator with $V = 30\angle 30^\circ$. Verify the duality between the sources V and the current I_2 and I_3 using simulation.

6. See Fig. 12.40 in Chapter 12 (page 298) in the above book. Let $R_1 = R_2 = 2\text{k}\Omega$, $L = 10\text{mH}$ and $C = 40\text{nF}$. Implement this circuit in the simulator and perform the ac analysis to plot the frequency response.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, (Model Question Paper)

Course Code: ECT205

Course Name: NETWORK THEORY

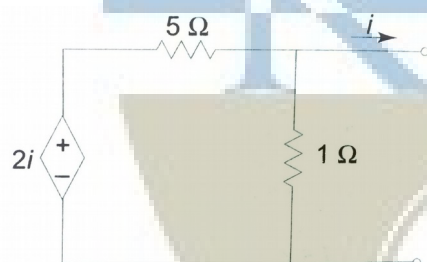
Max. Marks: 100

Duration: 3 Hours

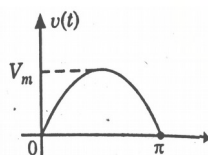
PART A

Answer ALL Questions. Each Carries 3 mark.

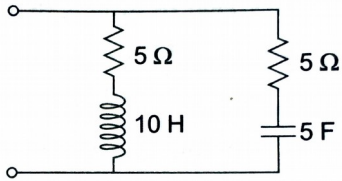
- 1 Illustrate the source-transformation techniques. K2
- 2 Explain the concept of supernode. K2
- 3 State and prove Maximum Power Transfer theorem K1
- 4 Evaluate the Norton's equivalent current in the following circuit. K3



- 5 Evaluate the Laplace Transform of half-wave rectified sine pulse. K3



- 6 Give the two forms of transformed impedance equivalent circuit of a capacitor with initial charge across it. K2
- 7 Enumerate necessary condition for a Network Functions to be Transfer Functions. K1
- 8 Obtain the pole zero configuration of the impedance function of the following circuit. K3



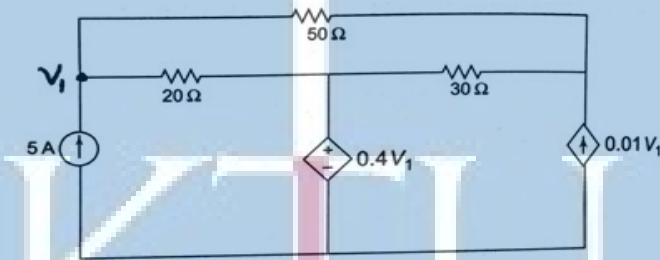
- 9 Define the short-circuit admittance parameter with its equivalent circuit. K2
- 10 Deduce Z-parameter in terms of h-parameter. K2

PART - B

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

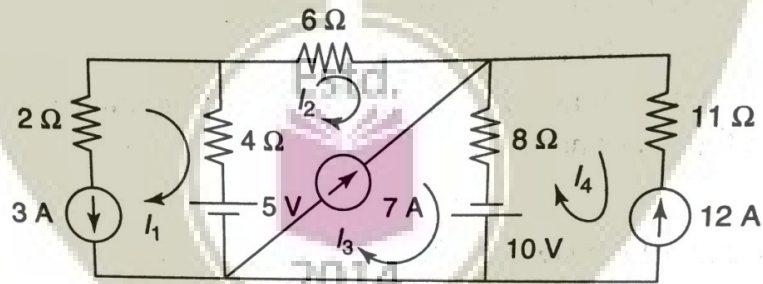
Module - I

- 11 Find the voltage V_1 using nodal analysis. 7
- a.



CO1
K3

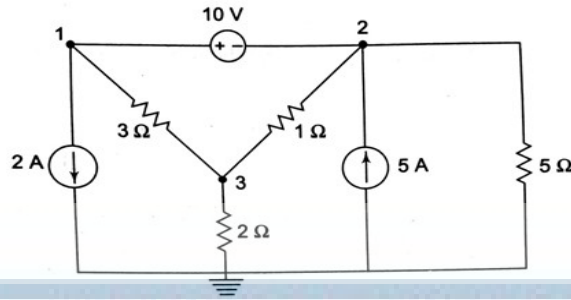
- b. Find the current through 8 ohms resistor in the following circuit using mesh analysis. 7



CO1
K3

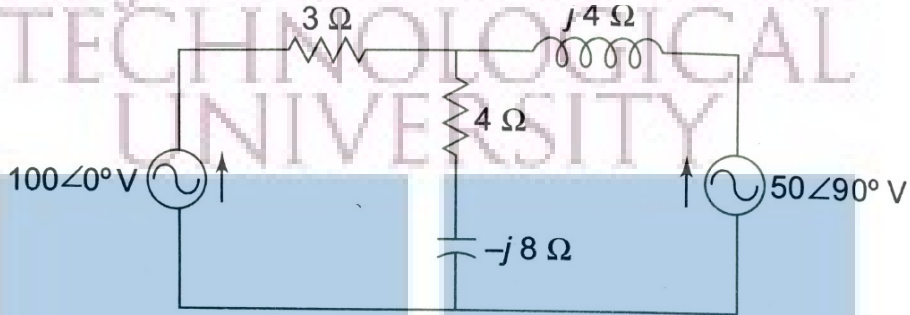
OR

- 12 Find the power delivered by the 5A current source using nodal analysis method. 7
- CO1
K3



b. Determine the values of source currents using Mesh analysis

7

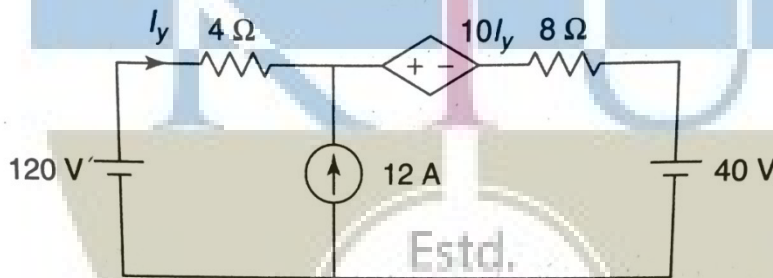


CO1
K3

Module - II

13 a. Find the current I_y by superposition principle.

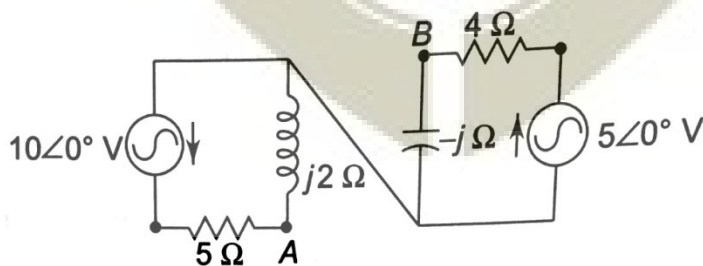
7



CO1
K3

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

7

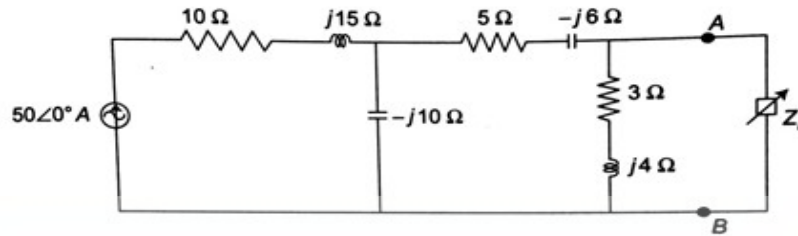


CO1
K3

OR

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

14



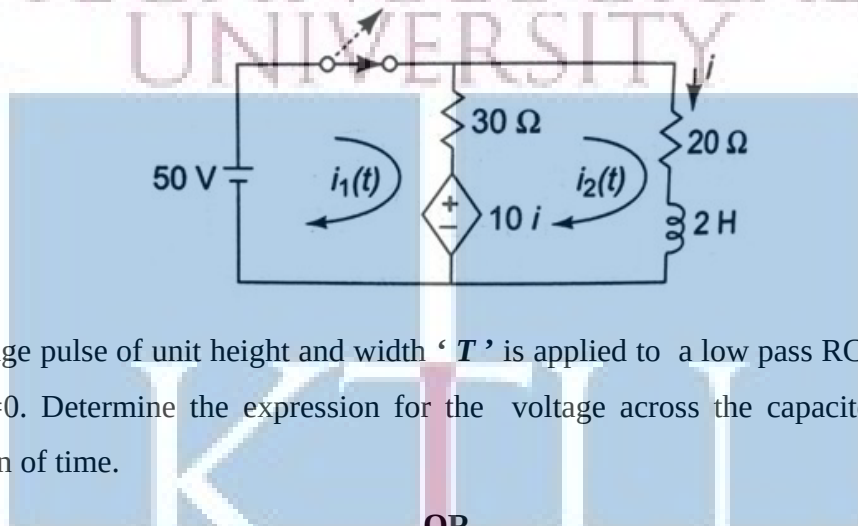
CO1

K3

Module - III

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

8



CO2

K3

- 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.

6

CO2

K3

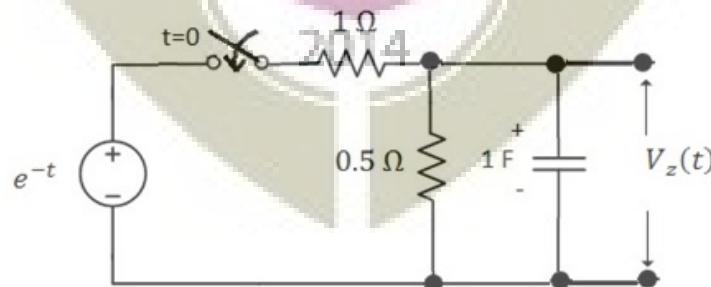
OR

- 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 $V_c(0) = 0.5V$. For the element values given, determine $V_z(t)$ after converting the circuit into transformed domain.

14

CO2

K3



Module - IV

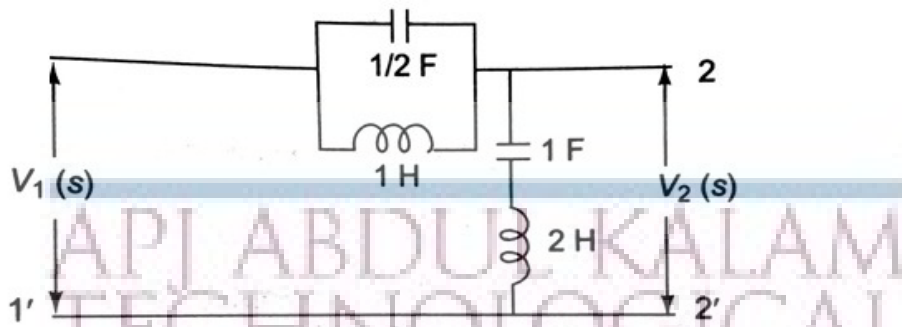
- 17 For the network, determine Driving point impedance $Z_{in}(s)$, Voltage gain Transfer

14

function $G_{21}(s)$ and Current gain Transfer function $\alpha_{21}(s)$.

CO3

K3



OR

18 a. Compare and contrast the necessary conditions for a network Driving point function and Transfer functions. 7

7

CO3

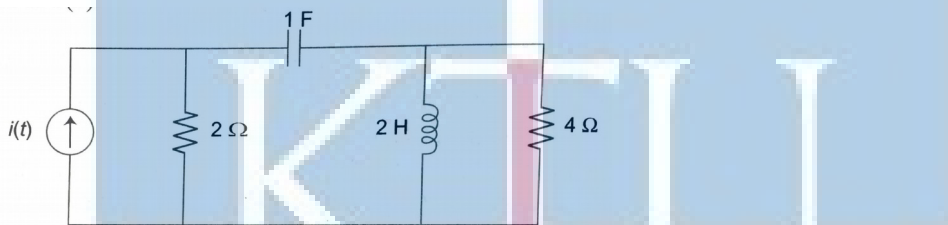
K2

b. For following network, evaluate the admittance function $Y(s)$ as seen by the source $i(t)$. Also plot the poles and zeros of $Y(s)$. 7

7

CO3

K3



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. 10

10

CO4

K2

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

4

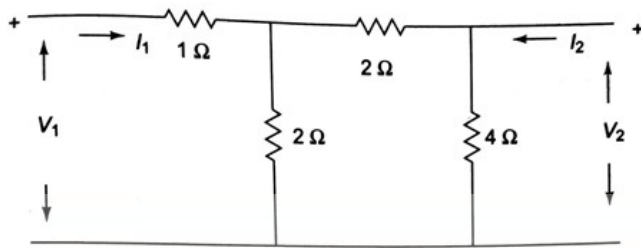
K2

OR

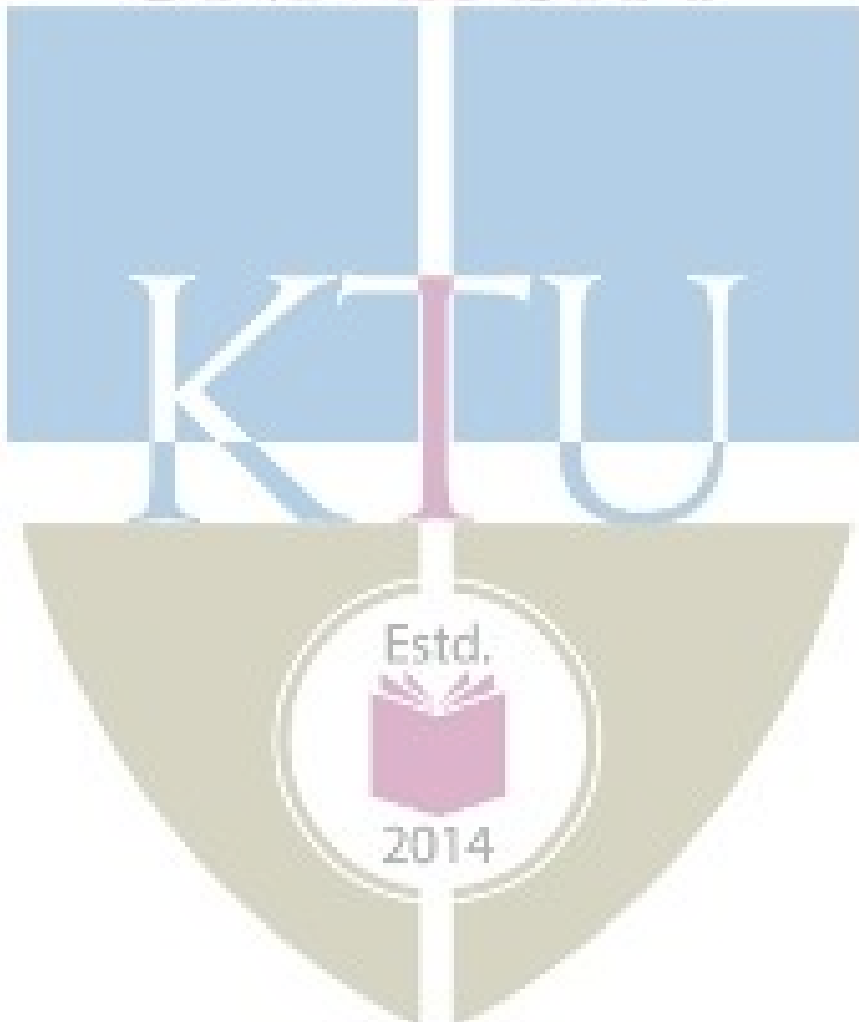
20 Two identical sections of the following networks are connected in parallel. Obtain the Y-parameters of the combination. 14

14

K3



APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY



ECL 201	SCIENTIFIC COMPUTING LABORATORY	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble

- The following experiments are designed to translate the mathematical concepts into system design.
- The students shall use Python for realization of experiments. Other softwares such as R/MATLAB/SCILAB/LabVIEW can also be used.
- The experiments will lay the foundation for future labs such as DSP lab.
- The first two experiments are mandatory and any six of the rest should be done.

Prerequisites

- MAT 101 Linear Algebra and Calculus
- MAT 102 Vector Calculus, Differential Equations and Transforms

Course Outcomes

The student will be able to

CO 1	Describe the needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization.
CO 2	Approximate an array/matrix with matrix decomposition.
CO 3	Implement numerical integration and differentiation.
CO 4	Solve ordinary differential equations for engineering applications
CO 5	Compute with exported data from instruments
CO 6	Realize how periodic functions are constituted by sinusoids
CO 7	Simulate random processes and understand their statistics.

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	3	1	0	3
CO2	3	3	1	2	3	0	0	0	3	0	0	1
CO3	3	3	1	1	3	0	0	0	0	0	0	1
CO4	3	3	1	1	3	0	0	0	0	0	0	1
CO5	3	3	1	3	0	0	0	0	3	3	0	0
CO6	3	3	2	2	3	0	0	0	3	1	0	0
CO7	3	3	2	2	3	0	0	0	3	1	0	1

Assessment Pattern**Mark Distribution**

Total Mark	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern

Attribute	Mark
Attendance	15
Continuous assessment	30
Internal Test (Immediately before the second series test)	30

End Semester Examination Pattern The following guidelines should be followed regarding award of marks.

Attribute	Mark
Preliminary work	15
Implementing the work/Conducting the experiment	10
Performance, result and inference (usage of equipments and trouble shooting)	25
Viva voce	20
Record	5

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

CO1-The needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization

1. Write a function to compute the first N Fibonacci numbers. Run this code and test it.
2. Write a function to compute the sum of N complex numbers. Run this code and test it.
3. Write a function to compute the factorial of an integer. Run this code and test it.

CO2-Approximation an array/matrix with matrix decomposition.

1. Write a function to compute the eigen values of a real valed valued matrix (say 5×5). Run this code. Plot the eigen values and understand their variation.
2. Write a function to approximate a 5×5 matrix using its first 3 eigen vales. Run the code and compute the absolute square error in the approximation.

CO3-Numerical Integration and Differentiation

1. Write and execute a function to return the first and second derivative of the function $f(t) = 3t^4 + 5$ for the vector $t = [-3, 3]$.
2. Write and execute a function to return the value of

$$\int_{-3}^3 e^{-|t|} dt$$

CO4-Solution of ODE

1. Write and execute a function to return the numerical solution of

$$\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 2x = e^{-t} \cos(t)$$

2. Write and execute a function to solve for the current transient through an RL network (with $\frac{r}{L} = 1$) that is driven by the signal $5e^{-t}U(t)$

CO5-Data Analysis

1. Connect a signal generator to a DSO and display a 1 V , 3 kHz signal. Store the trace in a USB device as a spreadsheet. Write and execute a function to load and display signal from the spreadsheet. Compute the RMS value of the signal.
2. Write and execute a program to display random data in two dimensions as continuous and discrete plots.

CO6-Convergence of Fourier Series

1. Write the Fourier series of a triangular signal. Compute this sum for 10 and 50 terms respectively. Plot both signals on the same GUI.

CO7-Simulation of Random Phenomena

1. Write and execute a function to toss three fair coins simultaneously. Compute the probability of getting exactly two heads for 100 and 1000 number of tosses.

Experiments**Experiment 1. Familiarization of the Computing Tool**

1. Needs and requirements in scientific computing
2. Familiarization of a programming language like Python/R/ MATLAB/SCILAB/LabVIEW for scientific computing
3. Familiarization of data types in the language used.
4. Familiarization of the syntax of *while*, *for*, *if* statements.
5. Basic syntax and execution of small scripts.

Experiment 2. Familiarization of Scientific Computing

1. Functions with examples
2. Basic arithmetic functions such as *abs*, *sine*, *real*, *imag*, *complex*, *sinc* etc. using built-in modules.
3. Vectorized computing without loops for fast scientific applications.

Experiment 3. Realization of Arrays and Matrices

1. Realize one dimensional array of real and complex numbers
2. stem and continuous plots of real arrays using *matplotlib/GUIs/charts*.
3. Realization of two dimensional arrays and matrices and their visualizations with *imshow/matshow/charts*
4. Inverse of a square matrix and the solution of the matrix equation

$$[\mathbf{A}][\mathbf{X}] = [\mathbf{b}]$$

where \mathbf{A} is an $N \times N$ matrix and \mathbf{X} and \mathbf{b} are $N \times 1$ vectors.

5. Computation of the rank(ρ) and eigen values (λ_i) of \mathbf{A}
6. Approximate \mathbf{A} for $N = 1000$ with the help of singular value decomposition of \mathbf{A} as

$$\tilde{\mathbf{A}} = \sum_{i=0}^r \lambda_i U_i V_i^T$$

where U_i and V_i are the singular vectors and λ_i are the eigen values with $\lambda_i < \lambda_j$ for $i > j$. One may use the built-in functions for singular value decomposition.

7. Plot the absolute error(ζ) between \mathbf{A} and $\tilde{\mathbf{A}}$ as $\zeta = \sum_{i=1}^N \sum_{j=1}^N |a_{i,j} - \tilde{a}_{i,j}|^2$ against r for $r = 10, 50, 75, 100, 250, 500, 750$ and appreciate the plot.

Experiment 4. Numerical Differentiation and Integration

1. Realize the functions $\sin t$, $\cos t$, $\sinh t$ and $\cosh t$ for the vector $t = [0, 10]$ with increment 0.01
2. Compute the first and second derivatives of these functions using built in tools such as *grad*.
3. Plot the derivatives over the respective functions and appreciate.
4. Familiarize the numerical integration tools in the language you use.
5. Realize the function

$$f(t) = 4t^2 + 3$$

and plot it for the vector $t = [-5, 5]$ with increment 0.01

6. Use general integration tool to compute

$$\int_{-2}^2 f(t) dt$$

7. Repeat the above steps with trapezoidal and Simpson method and compare the results.

8. Compute

$$\frac{1}{\sqrt{2\pi}} \int_0^{\infty} e^{-\frac{x^2}{2}} dx$$

using the above three methods.

Experiment 5. Solution of Ordinary Differential Equations

1. Solve the first order differential equation

$$\frac{dx}{dt} + 2x = 0$$

with the initial condition $x(0) = 1$

2. Solve for the current transient through an RC network (with $RC = 3$) that is driven by

- 5 V DC
- the signal $5e^{-t}U(t)$

and plot the solutions.

3. Solve the second order differential equation

$$\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = e^{-t}$$

4. Solve the current transient through a series RLC circuit with $R = 1\Omega$, $L = 1\text{ mH}$ and $C = 1\text{ }\mu\text{F}$ that is driven by

- 5 V DC
- the signal $5e^{-t}U(t)$

Experiment 6. Simple Data Visualization

1. Draw stem plots, line plots, box plots, bar plots and scatter plots with random data.
2. plot the histogram of a random data.
3. create legends in plots.
4. Realize a vector $t = [-10, 10]$ with increment 0.01 as an array.
5. Implement and plot the functions

- $f(t) = \cos t$
- $f(t) = \cos t \cos 5t + \cos 5t$

Experiment 7. Simple Data Analysis with Spreadsheets

1. Display an electrical signal on DSO and export it as a *.csv* file.
2. Read this *.csv* or *.xls* file as an array and plot it.
3. Compute the mean and standard deviation of the signal. Plot its histogram with an appropriate bin size.

Experiment 8. Convergence of Fourier Series

1. The experiment aims to understand the lack of convergence of Fourier series
2. Realize the Fourier series

$$f(t) = \frac{4}{\pi} \left[1 - \frac{1}{3} \cos \frac{2\pi 3t}{T} + \frac{1}{5} \cos \frac{2\pi 5t}{T} - \frac{1}{7} \cos \frac{2\pi 7t}{T} + \dots \right]$$

3. Realize the vector $t = [0, 100]$ with an increment of 0.01 and keep $T = 20$.
4. Plot the first 3 or 4 terms on the same graphic window and understand how the smooth sinusoids add up to a discontinuous square function.
5. Compute and plot the series for the first 10, 20, 50 and 100 terms of the and understand the lack of convergence at the points of discontinuity.
6. With t made a zero vector, $f(0) = 1$, resulting in the *Madhava* series for π as

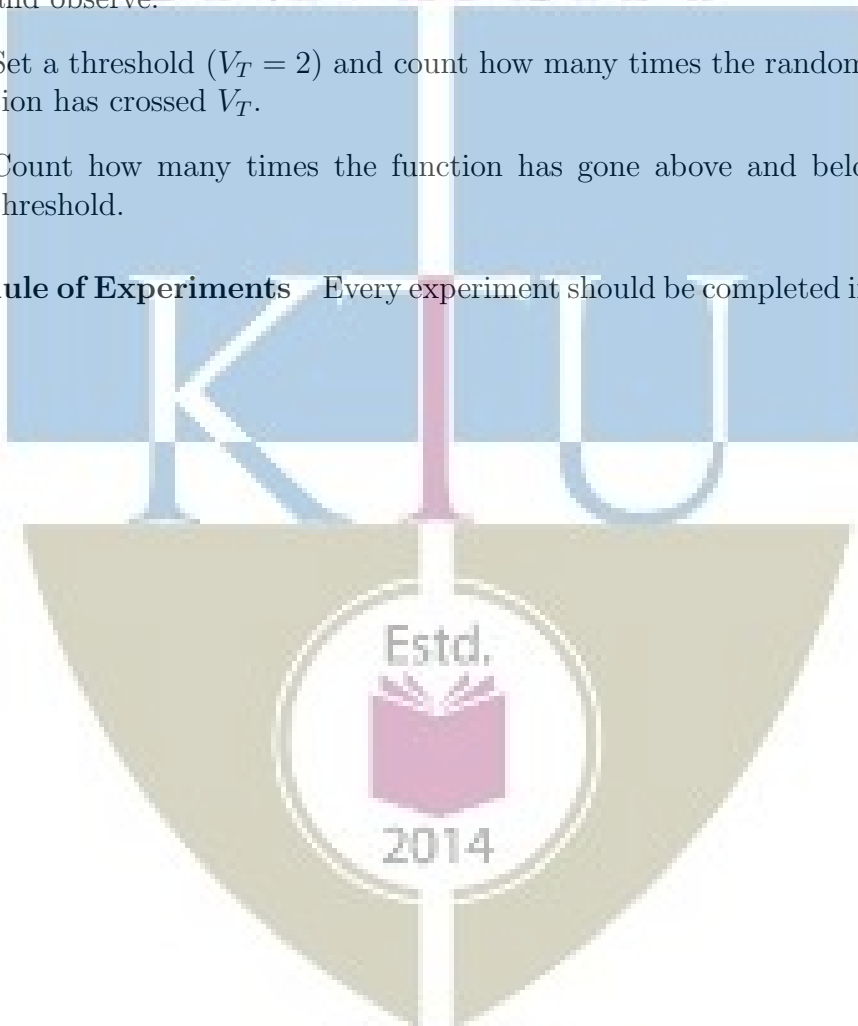
$$\pi = 4 \left[1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots \right]$$

7. Use this to compute π for the first 10, 20, 50 and 100 terms.

Experiment 9: Coin Toss and the Level Crossing Problem

1. Simulate a coin toss that maps a head as 1 and tail as 0.
2. Toss the coin $N = 100, 500, 1000, 5000$ and 500000 times and compute the probability (p) of head in each case.
3. Compute the absolute error $|0.5 - p|$ in each case and plot against N and understand the law of large numbers.
4. Create a uniform random vector with maximum magnitude 10, plot and observe.
5. Set a threshold ($V_T = 2$) and count how many times the random function has crossed V_T .
6. Count how many times the function has gone above and below the threshold.

Schedule of Experiments Every experiment should be completed in three hours.



CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
				2	0	0
EST 200	DESIGN AND ENGINEERING					

Preamble:

The purpose of this course is to

- i) introduce the undergraduate engineering students the fundamental principles of design engineering,
- ii) make them understand the steps involved in the design process and
- iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

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

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

Mapping of course outcomes with program outcomes

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

Assessment Pattern**Continuous Internal Evaluation (CIE) Pattern:**

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.

Part A : 30 marks

part B : 70 marks

Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design
2. List the different stages in a design process.
3. Describe design thinking.
4. State the function of prototyping and proofing in engineering design.
5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design, 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering
6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.
2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.
3. Describe how a problem-based learning helps in creating better design engineering solutions.
4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3 (CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustrate the development of any simple product by passing through the different stages of design process
2. Show the graphical design communication with the help of detailed 2D or 3D drawings for any simple product.
3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Page 1 of 2

Reg No.: _____ Name: _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION**

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A**Answer all questions, each question carries 3 marks****Use only hand sketches**

- (1) Write about the basic design process.
- (2) Describe how to finalize the design objectives.
- (3) State the role of divergent-convergent questioning in design thinking.
- (4) Discuss how to perform design thinking in a team managing the conflicts.
- (5) Show how engineering sketches and drawings convey designs.
- (6) Explain the role of mathematics and physics in design engineering process.
- (7) Distinguish between project-based learning and problem-based learning in design engineering.
- (8) Describe how concepts like value engineering, concurrent engineering and reverse engineering influence engineering designs?
- (9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?
- (10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)**Part B****Answer any ONE question from each module. Each question carry 14 marks****Module 1**

- (11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.
- or**
- (12) Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13) Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14) Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16) Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar powered bus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18) Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19) Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20) Describe how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) an electrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process:-Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Biomimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

- 1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,
- 2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

- 1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.
2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5
3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361
4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	<u>Module 1: Design Process</u>	
1.1	Introduction to Design and Engineering Design. <i>What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabulary in engineering design? How to learn and do engineering design.</i>	1
1.2	<i>Defining a Design Process-: Detailing Customer Requirements.</i> <i>How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?</i>	1
1.3	<i>Defining a Design Process-: Setting Design Objectives, Identifying Constraints, Establishing Functions.</i> <i>How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?</i>	1
1.4	<i>Defining a Design Process-: Generating Design Alternatives and Choosing a Design.</i> <i>How to generate or create feasible design alternatives? How to identify the "best possible design"?</i>	1
1.5	Case Studies:- Stages of Design Process. <i>Conduct exercises for designing simple products going through the different stages of design process.</i>	1
2	<u>Module 2: Design Thinking Approach</u>	
2.1	Introduction to Design Thinking <i>How does the design thinking approach help engineers in creating innovative and efficient designs?</i>	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. <i>How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?</i>	1
2.3	Design Thinking as Divergent-Convergent Questioning. <i>Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.</i>	1
2.4	Design Thinking in a Team Environment. <i>How to perform design thinking as a team managing the conflicts ?</i>	1
2.5	Case Studies: Design Thinking Approach. <i>Conduct exercises using the design thinking approach for</i>	1

	<i>designing any simple products within a limited time and budget</i>	
3	<u>Module 3: Design Communication (Languages of Engineering Design)</u>	
3.1	Communicating Designs Graphically. <i>How do engineering sketches and drawings convey designs?</i>	1
3.2	Communicating Designs Orally and in Writing. <i>How can a design be communicated through oral presentation or technical reports efficiently?</i>	1
First Series Examination		
3.3	Mathematical Modelling in Design. <i>How do mathematics and physics become a part of the design process?</i>	1
3.4	Prototyping and Proofing the Design. <i>How to predict whether the design will function well or not?</i>	1
3.5	Case Studies: Communicating Designs Graphically. <i>Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.</i>	1
4	<u>Module 4: Design Engineering Concepts</u>	
4.1	Project-based Learning and Problem-based Learning in Design. <i>How engineering students can learn design engineering through projects?</i> <i>How students can take up problems to learn design engineering?</i>	1
4.2	Modular Design and Life Cycle Design Approaches. <i>What is modular approach in design engineering? How it helps?</i> <i>How the life cycle design approach influences design decisions?</i>	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. <i>How do aesthetics and ergonomics change engineering designs?</i> <i>How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?</i>	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. <i>How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?</i>	1
4.5	Case Studies: Bio-mimicry based Designs. <i>Conduct exercises to develop new designs for simple</i>	1

	<i>products using bio-mimicry and train students to bring out new nature inspired designs.</i>	
5	<u>Module 5: Expediency, Economics and Environment in Design Engineering</u>	
5.1	Design for Production, Use, and Sustainability. <i>How designs are finalized based on the aspects of production methods, life span, reliability and environment?</i>	1
5.2	Engineering Economics in Design. <i>How to estimate the cost of a particular design and how will economics influence the engineering designs?</i>	1
5.3	Design Rights. <i>What are design rights and how can an engineer put it into practice?</i>	1
5.4	Ethics in Design. <i>How do ethics play a decisive role in engineering design?</i>	1
5.5	Case Studies: Design for Production, Use, and Sustainability. <i>Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.</i>	1
Second Series Examination		



Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	Professional Ethics	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Tests (2 Nos)	: 25 marks
Assignments/Quiz	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions**Course Outcome 1 (CO1):**

1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)

1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):

1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):

1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):

1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explore the need of environmental ethics in technological development.

Model Question paper

QP CODE:

Reg No: _____

PAGES:3

Name : _____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER
B.TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: HUT 200

Course Name: PROFESSIONAL ETHICS

Max. Marks: 100

Duration: 3 Hours

(2019-Scheme)

PART A**(Answer all questions, each question carries 3 marks)**

1. Define empathy and honesty.
2. Briefly explain about morals, values and ethics.
3. Interpret the two forms of self-respect.
4. List out the models of professional roles.
5. Indicate the advantages of using standards.
6. Point out the conditions required to define a valid consent?
7. Identify the conflicts of interests with an example?
8. Recall confidentiality.
9. Conclude the features of biometric ethics.
10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B**(Answer one full question from each module, each question carries 14 marks)****MODULE I****11. a)** Classify the relationship between ethical values and law?**b)** Compare between caring and sharing.

(10+4 = 14 marks)

Or**12. a)** Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment.

(8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, devised by Kohlberg.

b) Differentiate moral codes and optimal codes.

(10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics

(8+6 = 14 marks)

MODULE III

15.a) Summarize the following features of morally responsible engineers.

(i) Moral autonomy

(ii) Accountability

b) Explain the rights of employees

(8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty.

(8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example.

(8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.a) Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics.

(8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics.

(8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg’s theory- Gilligan’s theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. <http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics>.

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	Module 1 – Human Values.	
1.1	Morals, values and Ethics, Integrity, Academic Integrity, Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	Module 2- Engineering Ethics & Professionalism.	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy, Profession & Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	Module 3- Engineering as social Experimentation.	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics, Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	Module 4- Responsibilities and Rights.	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	Module 5- Global Ethical Issues.	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

CODE MCN201	SUSTAINABLE ENGINEERING	CATEGORY	L	T	P	CREDIT
			2	0	0	NIL

Preamble: Objective of this course is 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.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
CO 2	Explain the different types of environmental pollution problems and their sustainable solutions
CO 3	Discuss the environmental regulations and standards
CO 4	Outline the concepts related to conventional and non-conventional energy
CO 5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Mark distribution

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
Analyse			
Evaluate			
Create			

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
 Continuous Assessment Test (2 numbers) : 25 marks
 Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the relevance and the concept of sustainability and the global initiatives in this direction

1. Explain with an example a technology that has contributed positively to sustainable development.
2. Write a note on Millennium Development Goals.

Course Outcome 2 (CO2): Explain the different types of environmental pollution problems and their sustainable solutions

1. Explain the 3R concept in solid waste management?
2. Write a note on any one environmental pollution problem and suggest a sustainable solution.
3. In the absence of green house effect the surface temperature of earth would not have been suitable for survival of life on earth. Comment on this statement.

Course Outcome 3(CO3): Discuss the environmental regulations and standards

1. Illustrate Life Cycle Analysis with an example of your choice.
2. “Nature is the most successful designer and the most brilliant engineer that has ever evolved”. Discuss.

Course Outcome 4 (CO4): Outline the concepts related to conventional and non-conventional energy

1. Suggest a sustainable system to generate hot water in a residential building in tropical climate.
2. Enumerate the impacts of biomass energy on the environment.

Course Outcome 5 (CO5): Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

1. Suggest suitable measures to make the conveyance facilities used by your institution sustainable.

Model Question paper

Part A

(Answer all questions. Each question carries 3 marks each)

1. Define sustainable development.
2. Write a short note on Millennium Development Goals.
3. Describe carbon credit.
4. Give an account of climate change and its effect on environment.
5. Describe biomimicry? Give two examples.
6. Explain the basic concept of Life Cycle Assessment.
7. Name three renewable energy sources.

8. Mention some of the disadvantages of wind energy.
9. Enlist some of the features of sustainable habitat.
10. Explain green engineering.

Part B

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

11. Discuss the evolution of the concept of sustainability. Comment on its relevance in the modern world.
OR
12. Explain Clean Development Mechanism.
13. Explain the common sources of water pollution and its harmful effects.
OR
14. Give an account of solid waste management in cities.
15. Explain the different steps involved in the conduct of Environmental Impact Assessment.
OR
16. Suggest some methods to create public awareness on environmental issues.
17. Comment on the statement, "Almost all energy that man uses comes from the Sun".
OR
18. Write notes on:
 - a. Land degradation due to water logging.
 - b. Over exploitation of water.
19. Discuss the elements related to sustainable urbanisation.
OR
20. Discuss any three methods by which you can increase energy efficiency in buildings.

Syllabus

Sustainability- need and concept, technology and sustainable development-Natural resources and their pollution, Carbon credits, Zero waste concept. Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Sustainable urbanization, Industrial Ecology.

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.

Reference Books

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sustainability	
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	Environmental Pollution	
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	Environmental management standards	
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
3.6	Industrial Ecology, Industrial Symbiosis	1
4	Resources and its utilisation	
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	Sustainability Practices	
5.1	Basic concept of sustainable habitat	1
5.2	Methods for increasing energy efficiency of buildings	1
5.3	Green Engineering	1
5.4	Sustainable Urbanisation, Sustainable cities, Sustainable transport	1

ECL 201	SCIENTIFIC COMPUTING LABORATORY	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble

- The following experiments are designed to translate the mathematical concepts into system design.
- The students shall use Python for realization of experiments. Other softwares such as R/MATLAB/SCILAB/LabVIEW can also be used.
- The experiments will lay the foundation for future labs such as DSP lab.
- The first two experiments are mandatory and any six of the rest should be done.

Prerequisites

- MAT 101 Linear Algebra and Calculus
- MAT 102 Vector Calculus, Differential Equations and Transforms

Course Outcomes

CO	Outcome
CO 1	Describe the needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization.
CO 2	Approximate an array/matrix with matrix decomposition.
CO 3	Implement numerical integration and differentiation.
CO 4	Solve ordinary differential equations for engineering applications
CO 5	Compute with exported data from instruments
CO 6	Realize how periodic functions are constituted by sinusoids
CO 7	Simulate random processes and understand their statistics.

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	3	1	0	3
CO2	3	3	1	2	3	0	0	0	3	0	0	1
CO3	3	3	1	1	3	0	0	0	0	0	0	1
CO4	3	3	1	1	3	0	0	0	0	0	0	1
CO5	3	3	1	3	0	0	0	0	3	3	0	0
CO6	3	3	2	2	3	0	0	0	3	1	0	0
CO7	3	3	2	2	3	0	0	0	3	1	0	1

Assessment Pattern**Mark Distribution**

Total Mark	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern

Attribute	Mark
Attendance	15
Continuous assessment	30
Internal Test (Immediately before the second series test)	30

End Semester Examination Pattern The following guidelines should be followed regarding award of marks.

Attribute	Mark
Preliminary work	15
Implementing the work/Conducting the experiment	10
Performance, result and inference (usage of equipments and trouble shooting)	25
Viva voce	20
Record	5

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

CO1-The needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization

1. Write a function to compute the first N Fibonacci numbers. Run this code and test it.
2. Write a function to compute the sum of N complex numbers. Run this code and test it.
3. Write a function to compute the factorial of an integer. Run this code and test it.

CO2-Approximation an array/matrix with matrix decomposition.

1. Write a function to compute the eigen values of a real valed valued matrix (say 5×5). Run this code. Plot the eigen values and understand their variation.
2. Write a function to approximate a 5×5 matrix using its first 3 eigen vales. Run the code and compute the absolute square error in the approximation.

CO3-Numerical Integration and Differentiation

1. Write and execute a function to return the first and second derivative of the function $f(t) = 3t^4 + 5$ for the vector $t = [-3, 3]$.
2. Write and execute a function to return the value of

$$\int_{-3}^3 e^{-|t|} dt$$

CO4-Solution of ODE

1. Write and execute a function to return the numerical solution of

$$\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 2x = e^{-t} \cos(t)$$

2. Write and execute a function to solve for the current transient through an RL network (with $\frac{r}{L} = 1$) that is driven by the signal $5e^{-t}U(t)$

CO5-Data Analysis

1. Connect a signal generator to a DSO and display a 1 V , 3 kHz signal. Store the trace in a USB device as a spreadsheet. Write and execute a function to load and display signal from the spreadsheet. Compute the RMS value of the signal.
2. Write and execute a program to display random data in two dimensions as continuous and discrete plots.

CO6-Convergence of Fourier Series

1. Write the Fourier series of a triangular signal. Compute this sum for 10 and 50 terms respectively. Plot both signals on the same GUI.

CO7-Simulation of Random Phenomena

1. Write and execute a function to toss three fair coins simultaneously. Compute the probability of getting exactly two heads for 100 and 1000 number of tosses.

Experiments**Experiment 1. Familiarization of the Computing Tool**

1. Needs and requirements in scientific computing
2. Familiarization of a programming language like Python/R/ MATLAB/SCILAB/LabVIEW for scientific computing
3. Familiarization of data types in the language used.
4. Familiarization of the syntax of *while*, *for*, *if* statements.
5. Basic syntax and execution of small scripts.

Experiment 2. Familiarization of Scientific Computing

1. Functions with examples
2. Basic arithmetic functions such as *abs*, *sine*, *real*, *imag*, *complex*, *sinc* etc. using built-in modules.
3. Vectorized computing without loops for fast scientific applications.

Experiment 3. Realization of Arrays and Matrices

1. Realize one dimensional array of real and complex numbers
2. stem and continuous plots of real arrays using *matplotlib/GUIs/charts*.
3. Realization of two dimensional arrays and matrices and their visualizations with *imshow/matshow/charts*
4. Inverse of a square matrix and the solution of the matrix equation

$$[\mathbf{A}][\mathbf{X}] = [\mathbf{b}]$$

where \mathbf{A} is an $N \times N$ matrix and \mathbf{X} and \mathbf{b} are $N \times 1$ vectors.

5. Computation of the rank(ρ) and eigen values (λ_i) of \mathbf{A}
6. Approximate \mathbf{A} for $N = 1000$ with the help of singular value decomposition of \mathbf{A} as

$$\tilde{\mathbf{A}} = \sum_{i=0}^r \lambda_i U_i V_i^T$$

where U_i and V_i are the singular vectors and λ_i are the eigen values with $\lambda_i < \lambda_j$ for $i > j$. One may use the built-in functions for singular value decomposition.

7. Plot the absolute error(ζ) between \mathbf{A} and $\tilde{\mathbf{A}}$ as $\zeta = \sum_{i=1}^N \sum_{j=1}^N |a_{i,j} - \tilde{a}_{i,j}|^2$ against r for $r = 10, 50, 75, 100, 250, 500, 750$ and appreciate the plot.

Experiment 4. Numerical Differentiation and Integration

1. Realize the functions $\sin t$, $\cos t$, $\sin ht$ and $\cos ht$ for the vector $t = [0, 10]$ with increment 0.01
2. Compute the first and second derivatives of these functions using built in tools such as *grad*.
3. Plot the derivatives over the respective functions and appreciate.
4. Familiarize the numerical integration tools in the language you use.
5. Realize the function

$$f(t) = 4t^2 + 3$$

and plot it for the vector $t = [-5, 5]$ with increment 0.01

6. Use general integration tool to compute

$$\int_{-2}^2 f(t) dt$$

7. Repeat the above steps with trapezoidal and Simpson method and compare the results.

8. Compute

$$\frac{1}{\sqrt{2\pi}} \int_0^{\infty} e^{-\frac{x^2}{2}} dx$$

using the above three methods.

Experiment 5. Solution of Ordinary Differential Equations

1. Solve the first order differential equation

$$\frac{dx}{dt} + 2x = 0$$

with the initial condition $x(0) = 1$

2. Solve for the current transient through an RC network (with $RC = 3$) that is driven by

- 5 V DC
- the signal $5e^{-t}U(t)$

and plot the solutions.

3. Solve the second order differential equation

$$\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = e^{-t}$$

4. Solve the current transient through a series RLC circuit with $R = 1\Omega$, $L = 1\text{ mH}$ and $C = 1\text{ }\mu\text{F}$ that is driven by

- 5 V DC
- the signal $5e^{-t}U(t)$

Experiment 6. Simple Data Visualization

1. Draw stem plots, line plots, box plots, bar plots and scatter plots with random data.
2. plot the histogram of a random data.
3. create legends in plots.
4. Realize a vector $t = [-10, 10]$ with increment 0.01 as an array.
5. Implement and plot the functions

- $f(t) = \cos t$
- $f(t) = \cos t \cos 5t + \cos 5t$

Experiment 7. Simple Data Analysis with Spreadsheets

1. Display an electrical signal on DSO and export it as a *.csv* file.
2. Read this *.csv* or *.xls* file as an array and plot it.
3. Compute the mean and standard deviation of the signal. Plot its histogram with an appropriate bin size.

Experiment 8. Convergence of Fourier Series

1. The experiment aims to understand the lack of convergence of Fourier series
2. Realize the Fourier series

$$f(t) = \frac{4}{\pi} \left[1 - \frac{1}{3} \cos \frac{2\pi 3t}{T} + \frac{1}{5} \cos \frac{2\pi 5t}{T} - \frac{1}{7} \cos \frac{2\pi 7t}{T} + \dots \right]$$

3. Realize the vector $t = [0, 100]$ with an increment of 0.01 and keep $T = 20$.
4. Plot the first 3 or 4 terms on the same graphic window and understand how the smooth sinusoids add up to a discontinuous square function.
5. Compute and plot the series for the first 10, 20, 50 and 100 terms of the and understand the lack of convergence at the points of discontinuity.
6. With t made a zero vector, $f(0) = 1$, resulting in the *Madhava* series for π as

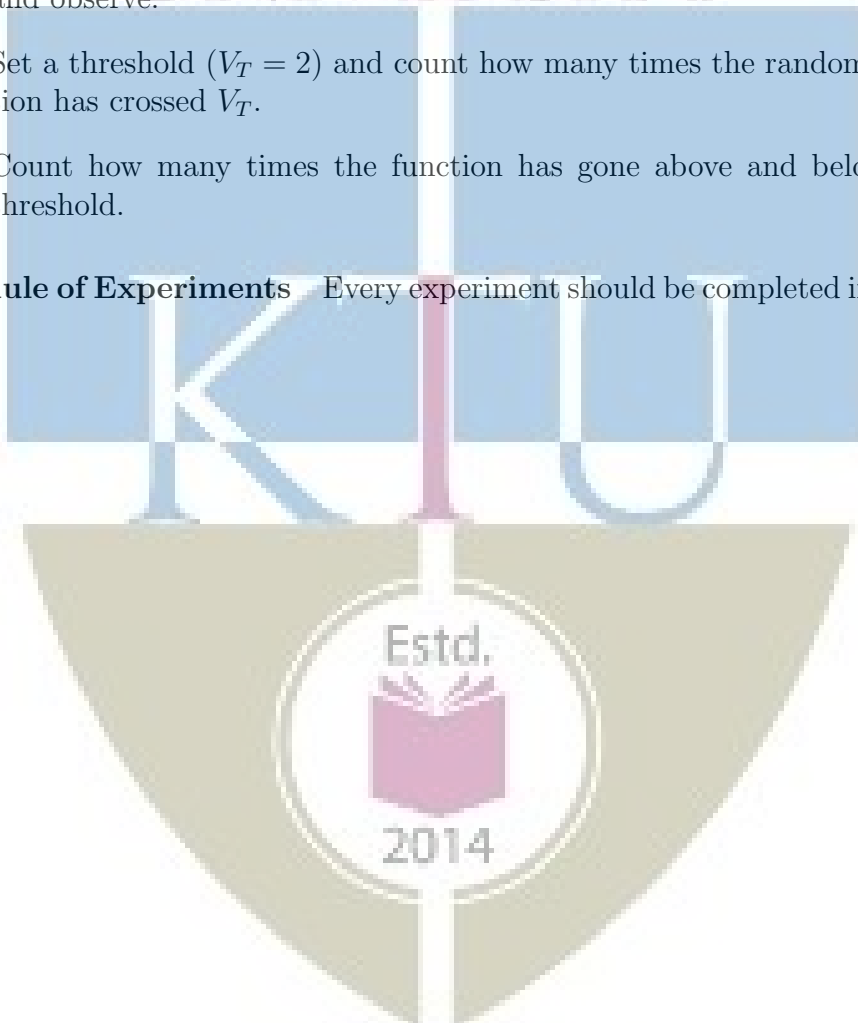
$$\pi = 4 \left[1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots \right]$$

7. Use this to compute π for the first 10, 20, 50 and 100 terms.

Experiment 9: Coin Toss and the Level Crossing Problem

1. Simulate a coin toss that maps a head as 1 and tail as 0.
2. Toss the coin $N = 100, 500, 1000, 5000$ and 500000 times and compute the probability (p) of head in each case.
3. Compute the absolute error $|0.5 - p|$ in each case and plot against N and understand the law of large numbers.
4. Create a uniform random vector with maximum magnitude 10, plot and observe.
5. Set a threshold ($V_T = 2$) and count how many times the random function has crossed V_T .
6. Count how many times the function has gone above and below the threshold.

Schedule of Experiments Every experiment should be completed in three hours.



ECL 203	LOGIC DESIGN LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to (i) familiarize students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates (ii) familiarize students with the HDL based Digital Design Flow.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design and demonstrate the functioning of various combinational and sequential circuits using ICs
CO 2	Apply an industry compatible hardware description language to implement digital circuits
CO 3	Implement digital circuits on FPGA boards and connect external hardware to the boards
CO 4	Function effectively as an individual and in a team to accomplish the given task

Mapping of course outcomes with program outcomes

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

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
 Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

- | | |
|--|------------|
| (a) Preliminary work | : 15 Marks |
| (b) Implementing the work/Conducting the experiment | : 10 Marks |
| (c) Performance, result and inference (usage of equipments and trouble shooting) | : 25 Marks |
| (d) Viva voce | : 20 marks |
| (e) Record | : 5 Marks |

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1): Design and Development of combinational circuits

1. Design a one bit full adder using gates and implement and test it on board.
2. Implement and test the logic function $f(A,B,C)=\sum m(0,1,3,6)$ using an 8:1 Mux IC
3. Convert a D flip-flop to T flip-flop and implement and test on board.

Course Outcome 2 and 3 (CO2 and CO3): Implementation of logic circuits on tiny FPGA

1. Design and implement a one bit subtracter in Verilog and implement and test it on a tiny FPGA board.
2. Design and implement a J-K flip-flop in Verilog, implement and test it on a tiny FPGA board.
3. Design a 4:1 Multiplexer in Verilog and implement and test it on tiny FPGA board.

List of Experiments:

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).
2. Design and Realization of half /full adder and subtractor using basic gates and universal gates.
3. 4 bit adder/subtractor and BCD adder using 7483.
4. Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.
5. Asynchronous Counter:3 bit up/down counter

6. Asynchronous Counter: Realization of Mod N counter
7. Synchronous Counter: Realization of 4-bit up/down counter.
8. Synchronous Counter: Realization of Mod-N counters.
9. Ring counter and Johnson Counter. (using FF & 7495).
10. Realization of counters using IC's (7490, 7492, 7493).
11. Multiplexers and De-multiplexers using gates and ICs. (74150, 74154)
12. Realization of combinational circuits using MUX & DEMUX.
13. Random Sequence generator using LFSR.

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.

Experiment 1. Realization of Logic Gates and Familiarization of FPGAs

- (a) Familiarization of a small FPGA board 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.

Experiment 2: Adders in Verilog

- (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.

Experiment 3: Mux and Demux in Verilog

- (a) Development of verilog modules for a 4x1 MUX.
- (b) Development of verilog modules for a 1x4 DEMUX.

Experiment 4: Flipflops and counters

- (a) Development of verilog modules for SR, JK and D flipflops.
- (b) Development of verilog modules for a binary decade/Johnson/Ring counters

Experiment 5. Multiplexer and Logic Implementation in FPGA

- (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.

Experiment 6. Flip-Flops and their Conversion in FPGA

- (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

Experiment 7: Asynchronous and Synchronous Counters in FPGA

- (a) Make a design of a 4-bit up down ripple counter using T-flip-flops 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-flops in the previous experiment, implement and test them on the FPGA board.

Experiment 8: Universal Shift Register in FPGA

- (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.

Experiment 9. BCD to Seven Segment Decoder in FPGA

- (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 output ports for connection to the display.

