SEMESTER -3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET201	**CIRCUITS AND NETWORKS**	**PCC**	**2**	**2**	**0**	**4**

Preamble : This course introduces circuit analysis techniques applied to dc and ac electric circuits. Analyses of electric circuits in steady state and dynamic conditions are discussed. Network analysis is introduced with network parameters and transfer functions. This course serves as the most important prerequisite of all many advanced courses in electrical engineering.

Prerequisite : **Basics of Electrical Engineering / Introduction to Electrical Engineering**

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

CO 1	Apply circuit theorems to simplify and solve complex DC and AC electric networks.
CO 2	Analyse dynamic DC and AC circuits and develop the complete response to excitations.
CO 3	Solve dynamic circuits by applying transformation to s-domain.
CO 4	Analyse three-phase networks in Y and Δ configurations.
CO 5	Solve series /parallel resonant circuits.
CO 6	Develop the representation of two-port networks using network parameters and analyse.

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
CO 4	3	3										2
CO 5	3	3										2
CO 6	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	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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. State and explain network theorems (K1)
2. Problems on solving circuits using network theorems. (K2, K3)

Course Outcome 2 (CO2):

1. Distinguish between the natural response and forced response. (K2, K3)
2. Problems on steady state and transient analysis of RL, RC and RLC series circuits with DC excitation and initial conditions. (K2, K3)
3. Problems on steady state and transient analysis of RL, RC and RLC series circuits with sinusoidal excitation. (K2, K3)

Course Outcome 3 (CO3):

1. Problems on mesh analysis and node analysis of transformed circuits in s-domain (K2, K3).
2. Problems on solution of transformed circuits including mutually coupled circuits in s-domain (K2, K3).

Course Outcome 4 (CO4):

1. Problems on analysis of unbalanced Y and Δ configurations. (K2, K3)
2. Evaluation of neutral shift voltage in unbalanced systems. (K2, K3).

Course Outcome 5 (CO5):

1. Define Bandwidth, and draw the frequency dependence of impedance of an RLC network. (K1).
2. Develop the impedance/admittance Vs frequency plot for the given RLC network. (K2).
3. Evalutate the parameters such as quality factor, bandwidth,

Course Outcome 6 (CO6):

1. Problems on finding Z, Y, h and T parameters of simple two port networks. (K2).
2. Derive the expression for Z parameters in terms of T parameters. (K1).
3. Show that the overall transmission parameter matrix for cascaded 2 port network is simply the matrix product of transmission parameters for each individual 2 port network in cascade. (K1).

Model Question paper

QP CODE:

PAGES:4

Reg. No:______________
Name:______________

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

Course Code: EET 201

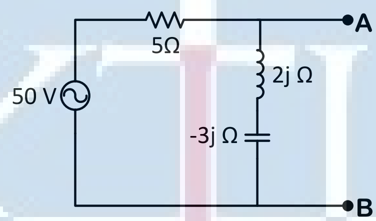
Course Name: CIRCUITS AND NETWORKS

Max. Marks: 100 Duration: 3 Hours

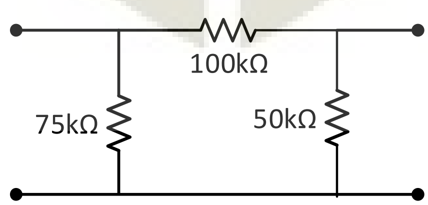
PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. State and explain superposition theorem using an example.
2. Obtain Thevenin's equivalent for the following circuit w.r.t terminals A and B:



3. Define time constant of a circuit. What is the time constant of an RL circuit?
4. How are RLC networks classified according to damping ratios? Sketch the various responses when an RLC series circuit is excited by a DC source.
5. Explain the dot convention used in coupled circuits.
6. Derive the s-domain equivalent circuit of an inductor carrying an initial current of Io.
7. Describe the variation of impedance and phase angle as a function of frequency in a series RLC circuit.
8. Define quality factor. Derive quality factor for inductive and capacitive circuits.
9. Derive the condition for symmetry & reciprocity in terms of T parameters.
10. Obtain Y parameters of the following network:

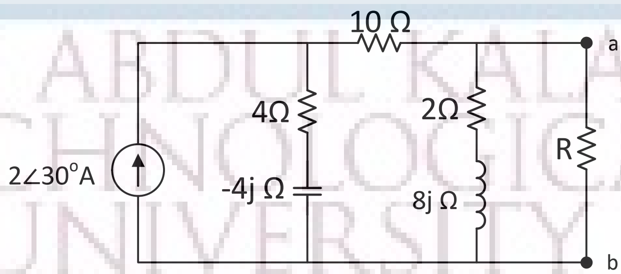


PART B (14 x 5 = 70 Marks)

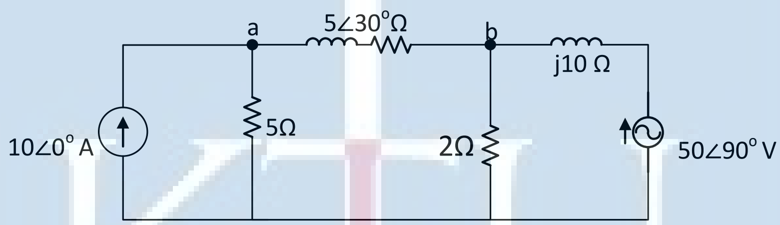
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. With respect to the following circuit,
    a) Find the value of Resistor 'R' that results in maximum power transfer to it. **(10)**
    b) Find the value of maximum power transferred to 'R'. **(4)**

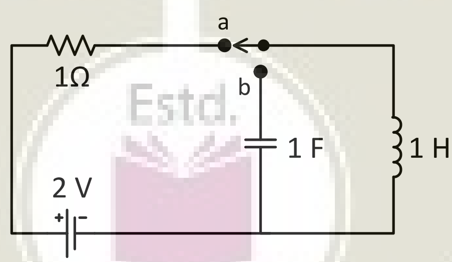


12. With respect to the following circuit,
    a) Find the voltages at 'a' and 'b' using superposition theorem. **(10)**
    b) Obtain the active power dissipated in $5\angle 30^{o}\Omega$ impedance. **(4)**

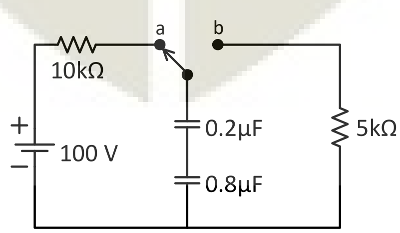


Module 2

13. a) In the following circuit, steady state exits when switch is in position 'a'. At time t = 0, the switch is moved to position 'b' .Obtain an expression for inductor current for time t > 0 **(6)**

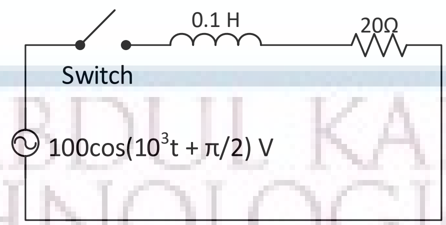


b) For the following circuit, switch 'S' is in position 'a' for a very long time. At time t = 0, the switch is thrown to position 'b'. Find the expression for current through 5kΩ. **(8)**



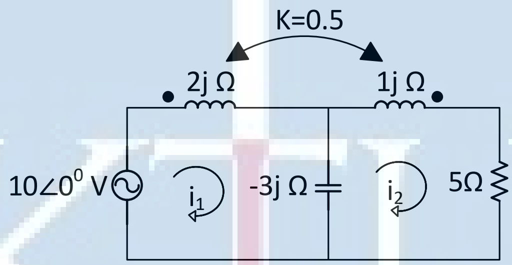
14. a) Given an RC circuit with zero initial charge on capacitor. Find the expression forcurrent after a DCsource 'V_{DC}' is applied to the RC network. Also determine thetime constantofthe circuit. **(4)**

b) Obtain an expression for current in the following circuit after switch is closed attime t=0. Use Laplace transform method. **(10)**

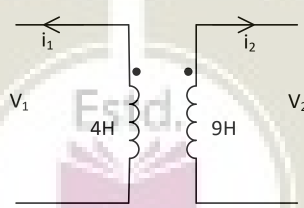


Module 3

15. a) For the following coupled circuit, the coupling coefficient, K =0.5. Write the KVL equations for currents i_1 and i_2. Also obtain the voltage drop across 5Ω resistor. **(10)**



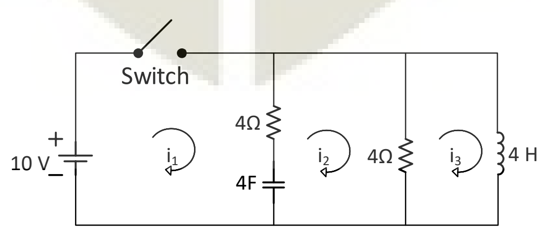
b) In figure, L_1=4H, L_2=9H, coefficient of coupling K=0.5,i_1 = 5 cos(50t-300) Amps, i_2 = 2cos(50t-300) Amps. Write the KVL equations for V_1 and V_2. Find their values at t=0 **(4)**



16. In the circuit shown, at time t = 0, the switch was closed.

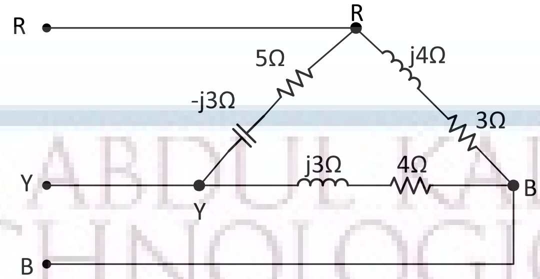
a. Model the circuit in s-domain for time t > 0. **(4)**

b. Through mesh analysis, obtain the time domain values of values of i_1, i_2 and i_3 Given that the capacitor and inductor were initially relaxed. **(10)**



Module 4

17. The following load is delta connected to a 100V three phase system. Find the phase currents, line currents and total power consumed by the load. **(14)**



18. An unbalanced 4 wire, star connected load is connected to a balanced voltage of 400V.
The loads are: $Z_1 = (3 + 6j)\Omega; Z_2 = (2 + 2j)\Omega; Z_3 = (14 + 18j)\Omega$
Calculatea) Line currents **(4)**

b) Current in neutral wire **(4)**

c) Total power **(6)**

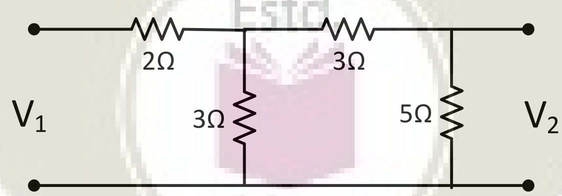
Module 5

19. a) Discuss series and parallel interconnection of 2-port networks. **(7)**

b) Derive the inter-relationship between Z and Y parameters. **(7)**

20. a) A network is given as $I_1 = 2.5V_1 - V_2; I_2 = -V_1 + 5V_2$
Draw its equivalentπ network. **(4)**

b) Obtain h parameters of the following network: **(10)**



Syllabus

Module 1

Circuit theorems: DC and Sinusoidal steady state analysis of circuits with dependent and independent sources applying Superposition principle, Source transformation, Thevenin's, Norton's and Maximum Power Transfer theorems - Reciprocity theorem.

Module 2

Analysis of first and second order dynamic circuits: Formulation of dynamic equations of RL, RC and RLC series and parallel networks with dc excitation and initial conditions and complete solution using Laplace Transforms - Time constant - Complete solution of RL, RC and RLC circuits with sinusoidal excitation using Laplace Transforms – Damping ratio – Over damped, under damped, critically damped and undamped RLC networks.

Module 3

Transformed circuits in s-domain: Transform impedance/admittance of R, L and C - Mesh analysis and node analysis of transformed circuits in s-domain. Transfer Function representation – Poles and zeros.

Analysis of Coupled Circuits: – Dot polarity convention – Sinusoidal steady state analysis of coupled circuits - Linear Transformer as a coupled circuit - Analysis of coupled circuits in s-domain.

Module 4

Three phase networks and resonance: Complex Power in sinusoidal steady state. Steady state analysis of three-phase three-wire and four-wire unbalanced Y circuits, Unbalanced Delta circuit, Neutral shift.

Resonance in Series and Parallel RLC circuits – Quality factor – Bandwidth – Impedance Vs Frequency, Admittance Vs Frequency, Phase angle Vs frequency for series resonant circuit.

Module 5

Two port networks: Driving point and transfer functions – Z, Y, h and T parameters **-** Conditions for symmetry & reciprocity – relationship between parameter sets – interconnections of two port networks (series, parallel and cascade) — T-π transformation.

Text Books

1. Joseph A. Edminister and MahmoodNahvi, "Theory and Problems in Electric circuits", McGraw Hill, 5th Edition, 2010.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References:

1. Hayt and Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, New Delhi, 8th Ed, 2013.
2. Van Valkenberg, "Network Analysis", Prentice Hall India Learning Pvt. Ltd., 3 edition, 1980.
3. K. S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
4. Chakrabarti, "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
5. R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 2010.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Network theorems - DC and AC steady state analysis (12 hours)**	
1.1	Linearity and Superposition principle - Application to the analysis of DC and AC (sinusoidal excitation) circuits. Application of source transformation in electric circuit analysis.	2
1.2	Thevenin's theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.3	Norton's theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.4	Maximum power transfer theorem - DC and AC steady state analysis with dependent and independent sources.	2
1.5	Reciprocity Theorem - Application to the analysis of DC and AC Circuits.	2
2	**First order and second order dynamic circuits. (9 hours)**	
2.1	Review of Laplace Transforms – Formulae of Laplace Transforms of common functions/signals, Initial value theorem and final value theorem, Inverse Laplace Transforms – partial fraction method. *(Questions to evaluate the Laplace/inverse transforms of any function / partial fractions method shall not be given in tests/final examination. Problems with application to circuits can be given).*	2
2.2	Formulation of dynamic equations of RL series and parallel networks and solution using Laplace Transforms – with DC excitation and initial	1

	conditions. Natural response and forced response. Time constant.	
2.3	Formulation of dynamic equations of RC series networks and solution using Laplace Transforms – with DC excitation and initial conditions. Natural response and forced response. Time constant.	1
2.4	Formulation of dynamic equations of RLC series networks with DC excitation and initial conditions, and solution using Laplace Transforms – Natural response and forced response. Damping coefficient. Underdamped, Overdamped, critically damped and undamped cases.	1
2.5	Formulation of dynamic equations of RL, RC and RLC series networks and solution with sinusoidal excitation. Complete solution (Solution using Laplace transforms).	2
2.6	Formulation of dynamic equations of RL, RC and RLC parallel networks and solution using Laplace Transforms – with DC and Sinusoidal excitations. Damping ratio.	2
3	**Transformed Circuits in s-domain and Coupled circuits (9 Hours)**	
3.1	Transformed circuits in s-domain: Transformation of elements (R, L, and C) with and without initial conditions.	2
3.2	Mesh analysis of transformed circuits in s-domain.	1
3.3	Node analysis of transformed circuits in s-domain.	1
3.4	Transfer Function representation – Poles and zeros.	1
3.5	Analysis of coupled circuits: mutual inductance – Coupling Coefficient- Dot polarity convention — Conductively coupled equivalent circuits. Linear Transformer as a coupled circuit.	2
3.6	Analysis of coupled circuits in s-domain.	2
4	**Three phase networks and resonance. (6 Hours)**	
4.1	Review of power, power factor, reactive and active power in sinusoidally excited circuits. Concept of complex power.	1
4.2	Steady state analysis of three-phase unbalanced 3-wire and 4-wire Y circuits, Unbalanced Δ circuits, Neutral shift.	2
4.3	Resonance in Series and Parallel RLC circuits – Quality factor – Bandwidth – Impedance Vs Frequency, Admittance Vs Frequency and Phase angleVs frequency for series resonant circuit.	3

5	**Two port networks (9 Hours)**	
5.1	Two port networks: Terminals and Ports, Driving point and transfer functions. Voltage transfer ratio, Current transfer ratio, transfer impedance, transfer admittance, poles and zeros.	2
5.2	Z –parameters. Equivalent circuit representation.	1
5.3	Y parameters. Equivalent circuit representation.	1
5.4	h parameters. Equivalent circuit representation.	1
5.5	T parameters.	1
5.6	Conditions for symmetry & reciprocity, relationship between network parameter sets.	1
5.7	Interconnections of two port networks (series, parallel and cascade).	1
5.8	T-π Transformation.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET203	**MEASUREMENTS AND INSTRUMENTATION**	PCC	**3**	**1**	**0**	**4**

Preamble : This course introduces principle of operation and construction of basic instruments for measurement of electrical quantities. Measurement of basic circuit parameters, magnetic quantities, and passive parameters by using bridge circuits, sensors and transducers will be discussed.Familiarization of modern digital measurement systems are also included.

Prerequisite **:Nil**

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

CO 1	Identify and analysethe factors affecting performance of measuring system
CO 2	Choose appropriate instruments for the measurement of voltage, current in ac and dc measurements
CO 3	Explain the operating principle of power and energy measurement
CO 4	Outline the principles of operation of Magnetic measurement systems
CO 5	Describe the operating principle of DC and AC bridges, transducersbased systems.
CO 6	Understand the operating principles of basic building blocks of digital systems, recording and display units

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	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	1	-	-	-	-	-	-	2
CO 6	3	-	-	-	2	-	-	-	-	-	-	2

Assessment Pattern

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	15	20	30
Understand	20	20	50
Apply	15	10	20
Analyse			
Evaluate			
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. Explain static characteristics of measuring systems.
2. Problems related to measurement errors.
3. Concept of calibration of measuring instruments

Course Outcome 2 (CO2):

1. Explain the construction and working indicating Instruments.
2. Problems related to extension of range of meters

Course Outcome 3(CO3):

1. Describe the principle of operation and construction of energy meter
2. Describe the principle of operation and construction of wattmeter
3. Problems related to two and three wattmeter method of power measurement.

Course Outcome 4 (CO4):

1. Explain the principle of operation of ballistic galvanometer.
2. Describe the procedure for plotting the B-H curve of a magnetic specimen.

Course Outcome 5 (CO5):

1. Explain classification of Transducers
2. Measurement of frequency using Wien bridge.
3. Explain the operation of basic ac/dc bridges
4. Illustrate the principle of temperature measurement using thermocouple.

Course Outcome 6 (CO6):

1. Block diagram of DMM, CRO, DSO, PMU
2. Basic ideas on simulation softwares and virtual instrumentation.
3. Explain the operation of basic ac/dc bridges

Model Question paper
QPCODE: PAGES:3

Reg.No:____________

Name :_____________

APJABDULKALAMTECHNOLOGICALUNIVERSITY THIRD SEMESTERB.TECHDEGREEEXAMINATION,

MONTH &YEAR

Course Code: EET 203

Course Name: Measurements and Instrumentation

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. What are the different standards of measurement?
2. State and briefly explain the classification of electrical measuring instruments.
3. What are the special features incorporated in low power factor wattmeter?
4. Write short note on three phase energy meter.
5. Describe the working of hall effect sensors.
6. With the help of a diagram indicate the calibration of wattmeter using DC potentiometer.
7. Describe the method of determination of BH curve of a magnetic material.
8. What are the main requirements in magnetic measurements?
9. Explain briefly about digital voltmeter.
10. What is lissajouspattern. Indicate the factors on which shape of these figures depends.

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

1. (a) Explain the essentials of indicating instruments and what are the different methods of producing controlling torque in an analog instrument? **(6)**

(b) Explain with the help of neat sketches, the construction and working of attraction type moving iron instruments. Give the equation for torque of the MI instrument and the merits and demerits. **(8)**

2. (a) Discuss different types of damping. What is the necessity of damping and how damping is provided in PMMC instrument? **(8)**

(b) A moving coil ammeter has fixed shunt of 0.01Ω. With a coil resistance of 750Ω and a voltage drop of 500mV across it, the full scale deflection is obtained. (1) Calculate current through shunt (2) Calculate resistance of meter to give full scale deflection if shunted current is 60A. **(6)**

Module 2

3. (a) Derive the expression for transformation ratio and phase angle of a current transformer using its equivalent circuit and phasor diagram. **(14)**

4. (a) Explain the construction and operation of dynamometer type wattmeter. **(7)**

(b) With a neat block diagram, explain the working of electronic energy meter. What are its merits compared to induction type energy meter. **(7)**

Module 3

5. (a) Draw the circuit and phasor diagram of schering bridge for the measurement of capacitance, Derive the expression for the unknown capacitance.**(10)**

(b) Explain loss of charge method for the measurement of high resistance. **(4)**

6. (a) Explain with the help of neat connection diagram how you would determine the value of low resistance by kelvin's double bridge method. Derive the formula used. **(7)**

(b) Describe the method of measurement of earth resistance and what are the factors which affect the value of earth resistance? **(7)**

Module 4

7. (a)Explain the method of measurement of permeability. **(5)**

(b) What is the principle of temperature measurement using thermistors and compare temperature measurement using RTD and thermistor. **(9)**

8. (a) Explain the working of flux meter. **(4)**

(b) What is a Llyod- Fisher square. Explain the measurement of iron losses in a magnetic material employing Llyod- Fisher square using wattmeter method. **(10)**

Module 5

9. (a) With the help of a neat sketch explain the working of LVDT. Also draw its characteristics. **(6)**

   (b) Explain how CRO can be used to measure the frequency and phase angle. **(8)**

10. (a) How strain is measured using strain gauge. **(4)**

   (b) With a neat diagram, explain the working of a digital storage oscilloscope. **(10)**

(14x5=70)

Syllabus

Module 1

Measurement standards–Errors-Types of Errors- Statistics of errors, Need for calibration.

Classification of instruments, secondary instruments–indicating, integrating and recording-operating forces - essentials of indicating instruments - deflecting, damping, controlling torques.

Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles shunts and multipliers – extension of range.

Module 2

Measurement of power: Dynamometer type wattmeter –Construction and working - 3-phase power measurement-Low Powerfactor wattmeters.

Measurement of energy: Induction type watt-hour meters- Single phase energy meter – construction and working, two element three phase energy meters,

Digital Energymeters -Time of Day(TOD) and Smart metering (description only).

Current transformers and potential transformers – principle of working -ratio and phase angle errors.

Extension of range using instrument transformers, Hall effect multipliers.

Module 3

Classification, measurement of low, medium and high resistance- Ammeter voltmeter method(for low and medium resistance measurements)-Kelvin's double bridge-Wheatstones bridge- loss of charge method, measurement of earth resistance.

Measurement of self inductance-Maxwell's Inductance bridge, Measurement of capacitance –Schering's, Measurement of frequency-Wien's bridge.

Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers.

High voltage and high current in DC measurements- voltmeters, Sphere gaps, DC Hall effect sensors.

Module 4

Magnetic Measurements: Measurement of flux and permeability - flux meter, BH curve and permeability measurement - hysteresis measurement- ballistic galvanometer – principle- determination of BH curve - hysteresis loop. Lloyd Fisher square — measurement of iron losses.

Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells

Temperature sensors-Resistance temperature detectors-negative temperature coefficient Thermistors-thermocouples-silicon temperature sensors.

Module 5

Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.

Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.

Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters.

Phasor Measurement Unit (PMU) (description only).

Introduction to Virtual Instrumentation systems- Simulation software's (description only)

Text Books

1. Sawhney A.K., A course in Electrical and Electronic Measurements & instrumentation, DhanpatRai.
2. J. B. Gupta, A course in Electrical & Electronic Measurement & Instrumentation., S K Kataria& Sons
3. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012
4. S Tumanski, Principles of electrical measurement, Taylor & Francis.
5. David A Bell, Electronic Instrumentation and Measurements,3/e, Oxford

Reference Books

1. Golding E.W., Electrical Measurements & Measuring Instruments, Wheeler Pub.
2. Cooper W.D., Modern Electronics Instrumentation, Prentice Hall of India
3. Stout M.B., Basic Electrical Measurements, Prentice Hall
4. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill
5. E.O Doebelin and D.N Manik, Doebelin's Measurements Systems, sixth edition, McGraw Hill Education (India) Pvt. Ltd.
6. P.Purkait, B.Biswas, S.Das and C. Koley, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education (India) Pvt. Ltd.,2013

Course Contents and Lecture Schedule

Module	Topic coverage	No. of Lectures	No of hours
1	**General principles of measurements and classification of meters**		
1.1	Measurement standards–Errors-Types of Errors- Statistics of errors, Need for calibration.	3	**10**
1.2	Classification of instruments, secondary instruments–indicating, integrating and recording- operating forces -	1	
1.3	Essentials of indicating instruments - deflecting, damping, controlling torques.	3	
1.4	Ammeters and voltmeters - moving coil, moving iron, constructional details and operation, principles shunts and multipliers – extension of range.	3	
2	**Measurement of Resistance, Power and Energy**		
2.1	Measurement of power: Dynamometer type wattmeter – Construction and working - 3-phase power measurement-Low Powerfactorwattmeters.	3	**09**
2.2	Measurement of energy: Induction type watt-hour meters-Single phase energy meter – construction and working, two element three phase energy meters, Digital Energymeters - Time of Day (TOD) and Smart metering (description only).	3	
2.3	Current transformers and potential transformers – principle of working -ratio and phase angle errors. Extension of range using instrument transformers, Hall effect multipliers.	3	
3	**Measurement of circuit parameters using bridges, High voltage and high current measurements**		
3.1	Classification of resistance, low resistance, Ammeter voltmeter method, Kelvin's double bridge Medium resistance- Ammeter voltmeter method - Wheatstones bridge High resistance- loss of charge method- measurement of earth resistance.	3	**09**
3.2	Measurement of self inductance-Maxwell's Inductance bridgeMeasurement of capacitance–Schering's bridge Measurement of frequency-Wien's bridge.	2	
3.3	Calibration of Ammeter, Voltmeter and Wattmeter using DC potentiometers.	2	
3.4	High voltage and high current in DC measurements-voltmeters, Sphere gaps, DC Hall effect sensors.	2	

4	**Magnetic, Lumen and Temperature Measurements**		
4.1	Measurement of flux and permeability - flux meter, BH curve and permeability measurement - hysteresis measurement	2	**08**
4.2	Ballistic galvanometer – principle- determination of BH curve - hysteresis loop. Lloyd Fisher square - measurement of iron losses.	2	
4.3	Measurement luminous intensity-Photoconductive Transducers-Photovoltaic cells	2	
4.4	Temperature sensors-Resistance temperature detectors-negative temperature coefficient Thermistors-thermocouples-silicon temperature sensors.	2	
5	**Transducers and Digital instruments including modern recording and displaying instruments**		
5.1	Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.	2	**09**
5.2	Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.	3	
5.3	Digital voltmeters and frequency meters using electronic counters, DMM, Clamp on meters.	2	
5.4	Phasor Measurement Unit (PMU) (description only). Introduction to Virtual Instrumentation systems-Simulation software's (description only)	2	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET205	**ANALOG ELECTRONICS**	PCC	3	1	0	4

Prerequisite: Fundamentals of Electronics and semiconductor devices

CO 1	Design biasing scheme for transistor circuits.
CO 2	Model BJT and FET amplifier circuits.
CO 3	Identify a power amplifier with appropriate specifications for electronic circuit applications.
CO 4	Describe the operation of oscillator circuits using BJT.
CO 5	Explain the basic concepts of Operational amplifier(OPAMP)
CO 6	Design and developvarious OPAMP application circuits.

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	2	2									
CO 2	2	2	2									
CO 3			1	2								
CO 4	2	2	2									
CO 5			1	2								
CO 6	2	2	2									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	50
Apply	20	20	40
Analyse	-	-	-
Evaluate	-	-	-
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. Discuss the different types of biasing methods.(K1,K2)
2. Comment on the effect of Bandwidth and slew rate in Op-amp performance.
3. Draw the Small signal equivalent of differential amplifier and derive the equations for Input resistance, Voltage gain, CMRR.

Course Outcome 2 (CO2):

1. Analyse JFET and MOSFET characteristics.
2. Choose a power amplifier with appropriate specifications for electronic circuit applications.
3. List the features of Instrumentation amplifier.
4. What are the various op-amp feedback configurations? Explain each.
5. Explain the following op-amp circuits with neat sketches also find the output voltage equations
   - **a.** Summing amplifiers
   - **b.** Scaling amplifiers
   - **c.** Averaging amplifiers

Course Outcome 3(CO3):

1. Discuss the different feedback topologies.
2. Analyse the properties of an ideal op-amp.
3. Describe the working of Voltage to current converter using op-amp.
4. Draw the circuit diagrams for Log and antilog amplifier and obtain its output equations.
5. With necessary waveforms and neat diagram explain the working of Schmitt Trigger.
6. Design a Wein Bridge oscillator for a gain of 3 and oscillating frequency of 2kHz.

Course Outcome 4 (CO4):

1. Draw the Small signal equivalent of differential amplifier and derive the equations for Input resistance, Voltage gain, CMRR. (K1, K2)
2. Design various basic op-amp circuits. (K2)
3. Explain the following op-amp circuits with neat sketches also find the output voltage equations
   - **a.** Summing amplifiers
   - **b.** Scaling amplifiers(K2,K3)

Course Outcome 5 (CO5):

1. Generate different desired waveforms using op-amp.(K2,K3)
2. Draw the internal block diagram of 555 Timer IC and explain.(K1)
3. Realise multivibrators using 555 IC. (K2,K3)

Course Outcome 6 (CO6):

1. Design and set up an opamp integrator circuit and plot the input and output waveforms.(K3)
2. Explain the working of a ramp generator circuit using opamp.(K2)

Model Question paper

PAGES: 2

Reg No.:_______________

Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITYTHIRD SEMESTER B.TECH DEGREE EXAMINATION,

MONTH AND YEAR

Course Code: EET205

Course Name: ANALOG ELECTRONICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks

1. With neat diagrams explain DC load lines in transistor. What is the significance of Q point?
2. Draw and explain the h parameter small signal low frequency model for BJT.
3. Explain the construction and operation of Enhancement type metal oxide semiconductor FET with neat diagrams.
4. Explain the drain characteristics of JFET and mark the pinch-off voltage
5. Discuss the advantages of negative feedback amplifier.
6. State and explain Barkhausen's criterion of oscillation.
7. Compare the Ideal and Practical characteristics of an op-amp
8. Design a three input summing amplifier using op-amp having gains 2, 3and 5 respectively for each input
9. Show the circuit diagram of an Ideal Differentiator using op-amp with corresponding input and output waveform.
10. Explain the operation of a square wave generator using op-amp.

PART B

Answeranyonefullquestionfromeachmodule.Eachquestioncarries14 Marks

Module1

11. Design a voltage divider bias circuit to operate from a 18V supply in which bias conditions are to be $V_{CE}=V_E=6V$ and $I_C=1.5mA$. β=90. Also calculate the stability factor S. **(14)**

12. A CE amplifier has the h-parameters given by h_{ie}= 1000Ω, h_{re} = $2*10^{-4}$, h_{fe}=50, h_{0e}= 25μΩ. If both the load and source resistances are 1kΩ, determine the a) current gain and b) voltage gain. **(14)**

Module 2

13. (a) Sketch the frequency response curve of RC coupled amplifier and discuss methods to improve gain bandwidth product **(7)**

(b) List the four parameters of JFET. Also obtain the mathematical expression for transconductance. **(7)**

14. (a) How a JFET common drain amplifier is designed using voltage divider biasing? **(5)**

(b)Which are the internal capacitances of a BJT? How these are incorporated in the high frequency hybid pi model of BJT? **(9)**

Module 3

15. Define conversion efficiency of power amplifier. Prove that the maximum conversion efficiency of a series fed class A amplifier is 25%. **(14)**

16. With neat circuit diagrams, explain the working of a two-stage RC coupled amplifier and derive the output relation of each stage. **(14)**

Module 4

17. How do the open-loop voltage gain and closed loop voltage gain of an op-amp differ? What is the limiting value of output voltage of op amp circuit? **(14)**

18. (a) An input of 3V is fed to the non inverting terminal of an op-amp. The amplifier has R_1=10kΩ and R_f=10kΩ.Find the output voltage. **(7)**

(b) Explain briefly about the following (i) CMRR (ii) Slew Rate **(7)**

Module 5

19. (a) What is the significance of UTP and LTP in Schmitt trigger circuits? **(7)**

(b) What is a zero crossing detector? **(7)**

20. (a) Explain the functional block diagram of Timer IC555. **(7)**

(b) Design an astablemultivibrator using 555 Timer for an output wave of 65% duty ratio at 1kHz frequency. **(7)**

Syllabus

Module 1

Bipolar Junction Transistors: Review of BJT characteristics- Operating point of BJT – Factors affecting stability of Q point. DC Biasing–Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilisation. Stability factor (Derivation of stability factors for Voltage Divider Biasing only).Numerical problems. Bias compensation using diode and thermistor.

BJT Model- h-parameter model of BJT in CE configuration. Small signal low frequency ac equivalent circuit of CE amplifier –Role of coupling capacitors and emitter bypass capacitor. Calculation of amplifier gains and impedances using h parameter equivalent circuit.

Module 2

Field Effect Transistors: Review of JFET and MOSFET(enhancement mode only) construction, working and characteristics- JFET common drain amplifier-Design using voltage divider biasing.

Frequency response of Amplifiers: Internal Capacitances at high frequency operations of BJT- Hybrid Pi model of BJT. Low and high frequency response of Common Emitter amplifier. Frequency response of CE amplifier, Gain bandwidth product.

Module 3

Multistage amplifiers: Direct, RC, transformer coupled Amplifiers, Applications.

Power amplifiers using BJT: Class A, Class B, Class AB, Class C and Class D. Conversion efficiency – derivation(Class A and Class B). Distortion in power amplifiers. Feedback in Amplifiers-Effect of positive and negative feedbacks.
Oscillators:Barkhausen'scriterion–
RCoscillators(RCPhaseshiftoscillatorandWeinBridgeoscillator) –LC oscillators(Hartley and Colpitt's)– Derivation of frequency of oscillation- Crystal oscillator.

Module 4

Operational Amplifiers: Fundamental differential amplifier- Modes of operation.

Properties of ideal and practical Op-amp - Gain, CMRR and Slew rate. Parameters of a typical Op-amp IC 741.

Open loop and Closed loop Configurations-Concept of virtual short. Negative feedback in Op-amps. Inverting and non- inverting amplifier circuits. Summing and difference amplifiers, Instrumentation amplifier.

Module 5

OP-AMP Circuits: Differentiator and Integrator circuits-practical circuits – Design –

Comparators: Zero crossing and voltage level detectors, Schmitt trigger. Comparator IC: LM311.

Wave form generation using Op-Amps: Square, triangular and ramp generator circuits using Op-Amp- Effect of slew rate on waveform generation.

Timer 555IC: Internal diagram of 555IC–Astable and Monostable multi-vibrators using 555 IC.

Text Books

1. Bell D. A., Electronic Devices and Circuits, Prentice Hall ofIndia, 2007.
2. Malvino A. and D. J. Bates, Electronic Principles7/e, Tata McGraw Hill, 2010.
3. Boylestad R. L. and L. Nashelsky,Electronic Devices and CircuitTheory, 10/e, PearsonEducation India, 2009.
4. Choudhury R.,LinearIntegrated Circuits, New AgeInternational Publishers. 2008.

Reference Books

3. Floyd T.L., Fundamentals of Analog Circuits,, Pearson Education, 2012.
4. Robert T. Paynter and John Clemons, Paynter's Introductory electronic devices & circuits, Prentice Hall Career & Technology, New Jersey.
5. Millman J. and C. C. Halkias,Integrated Electronics: Analog and Digital Circuits andSystems, Tata McGraw-Hill, 2010.
6. Streetman B. G. and S. Banerjee,Solid State Electronic Devices, Pearson Education Asia,2006.
7. Gayakward R. A., Op-Amps and LinearIntegrated Circuits, PHILearning Pvt.Ltd., 2012.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1		**10**
1.1	Bipolar Junction Transistors: Review of BJT characteristics	1
1.2	Operating point of BJT – Factors affecting stability of Q point.	1
1.3	Biasing circuits: fixed bias, collector to base bias, voltage divider bias, role of emitter resistance in bias stabilisation. Stability factor (Derivation of stability factors for Voltage Divider Biasing only). Numerical problems.	4
1.4	Bias compensation using diode and thermistor.	1
1.5	BJT Model- h-parameter model of BJT in CE configuration. Small signal low frequency ac equivalent circuit of CE amplifier	1
1.6	Role of coupling capacitors and emitter bypass capacitor.	1
1.7	Calculation of amplifier gains and impedances using h parameter equivalent circuit.	1
2		**8**
2.1	Field Effect Transistors: Review of JFET and MOSFET (enhancement mode)-construction, working and characteristics	2
2.2	JFET common drain amplifier-Design using voltage divider biasing.	1
2.3	FET as switch and voltage controlled resistance.	1
2.4	Frequency response of Amplifiers: Internal Capacitances at high frequency operations of BJT- Hybrid Pi model of BJT. Low and high frequency response of Common Emitter amplifier	3
2.5	Frequency response of CE amplifier, Gain bandwidth product	1
3		**9**
3.1	Multistage amplifiers: Direct, RC, Applications.	1
3.2	Transformer coupled Amplifiers, Applications.	1
3.3	Derivation of conversion efficiency of Class A and Class B amplifiers.	2

3.4	Class AB, Class C and Class D amplifiers. Distortion in power amplifiers(Class A, Class B, Class AB, Class C and Class D)	2
3.5	Oscillators: Barkhausen's criterion–RC oscillators (RC Phase shift oscillator and Wein Bridge oscillator) Derivation of frequency of oscillation	2
3.6	LC oscillators (Hartley and Colpitt's) – Derivation of frequency of oscillation- Crystal oscillator.	1
4		**10**
4.1	Operational Amplifiers: Fundamental differential amplifier- Modes of operation.	2
4.2	Properties of ideal and practical Op-amp - Gain, CMRR and Slew rate. Parameters of a typical Op-amp IC 741.	3
4.3	Open loop and Closed loop Configurations-Concept of virtual short.	2
4.4	Negative feedback in Op-amps.	1
4.5	Inverting and non- inverting amplifier circuits	1
4.6	Summing and difference amplifiers, Instrumentation amplifier.	1
5		**8**
5.1	OP-AMP Circuits: Differentiator and Integrator circuits-practical circuits - Design	1
5.2	Comparators: Zero crossing and voltage level detectors, Schmitt trigger. Comparator IC: LM311.	2
5.3	Wave form generation using Op-Amps: Square, triangular and ramp generator circuits using Op-Amp- Effect of slew rate on waveform generation.	2
5.4	Timer 555IC: Internal diagram of 555IC–Astable and Monostable multi-vibrators using 555 IC.	3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EEL201	**CIRCUITS AND MEASUREMENTS LAB**	**PCC**	**0**	**0**	**3**	**2**

Preamble : This laboratory course is designed to train the students to familiarize and practice various measuring instruments and different transducers for measurement of physical parameters. Students will also be introduced to a team working environment where they develop the necessary skills for planning, preparing and implementing basic instrumentation systems.

Prerequisite : Basic Electrical Engineering

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

CO 1	Analyse voltage current relations of RLC circuits
CO 2	Verify DC network theorems by setting up various electric circuits
CO 3	Measure power in a single and three phase circuits by various methods
CO 4	Calibrate various meters used in electrical systems
CO 5	Determine magnetic characteristics of different electrical devices
CO 6	Analyse the characteristics of various types of transducer systems
CO 7	Determine electrical parameters using various bridges
CO 8	Analyse the performance of various electronic devices for an instrumentation systems and, to develop the team management and documentation capabilities.

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						2			3
CO 2	3	3	-	-	-	-	-	-	2	-	-	3
CO 3	3	3	-	-	-	-	-	-	2	-	-	3
CO 4	3	3	2	-	-	-	-	-	2	-	-	3
CO 5	3	3	-	-	-	-	-	-	2	-	-	3
CO 6	3	3	2	-	-	-	-	-	2	-	-	3
CO 7	3	3	-	-	-	-	-	-	2	-	-	3
CO 8	3	3	3	3	2	-	-	-	3	3	3	3

ASSESSMENT PATTERN:

Mark distribution:

Total Marks	CIE marks	ESE marks	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Regular Lab work	Internal Test	Course Project	Total
15	30	25	5	**75**

Internal Test Evaluation (Immediately before the second series test)

End Semester Examination (ESE) 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 : Practical examination is to be conducted immediately after the second series test after conducting 12 experiments from the list of experiments given below. Evaluation is a serious process that 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 University examination only on submitting the duly certified record. The external examiner shall endorse the record.

LIST OF EXPERIMENTS:

(12 experiments are mandatory)

1. Verification of Superposition theorem and Thevenin's theorem**.**
2. Determination of impedance, admittance and power factor in RLC series/ parallel circuits.
3. 3-phase power measurement using one wattmeter and two-wattmeter methods, and determination of reactive/apparent power drawn.
4. Resistance measurement using Kelvin's Double Bridge and Wheatstone's Bridge and extension of range of voltmeters and ammeters.
5. Extension of instrument range by using Instrument transformers(CT and PT)
6. Calibration of ammeter, voltmeter, wattmeter using Potentiometers
7. Calibration of 1-phase Energy meter at various power factors (minimum 4 conditions)
8. Calibration of 3-phase Energy meter using standard wattmeter
9. Determination of B-H curve, μ-H curve and μ-B curve of a magnetic specimen
10. Measurement of Self inductance, Mutual inductance and Coupling coefficient of a 1-phase transformer
11. a. Measurement of Capacitance using AC bridge

    b. Setup an instrumentation amplifier using Opamps.
12. Determination of characteristics of LVDT, Strain gauge and Load-cell.
13. Determination of characteristics of Thermistor, Thermocouple and RTD
14. Verification of loading effect in ammeters and voltmeters with current measurement using Clamp on meter.

15. Demo Experiments/Simulation study:

(a) Measurement of energy using TOD meter

(b) Measurement of electrical variables using DSO

(c) Harmonic analysers

(d) Simulation of Circuits using software platform

(e) Computer interfaced measurements of circuit parameters.

Mandatory Group Project Work : Students have to do a mandatory micro project (group size not more than 5 students) to realise a functional instrumentation system. A report also is to be submitted. Performance can be evaluated along with the internal test and a maximum of 5 marks shall be awarded.

Example projects (Instrumentation system with sensors, alarm, display units etc)

1. Temperature Monitoring System.
2. Gas / Fire smoke Detection Systems.
3. Simulation using LabVIEW, PLC or Similar Softwares.

Reference Books:

1. A. K. Sawhney: A course in Electrical and Electronic Measurements & Instrumentation, Dhanpat Rai Publishers
2. J. B. Gupta: A course in Electrical & Electronic Measurement & Instrumentation., S. K. Kataria & Sons Publishers
3. Kalsi H. S.: Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi.

CODE EEL203	ANALOG ELECTRONICSLAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

CO 1	Use the various electronic instruments and for conducting experiments.
CO 2	Design and develop various electronic circuits using diodes and Zener diodes.
CO 3	Design and implement amplifier and oscillator circuits using BJT and JFET.
CO 4	Design and implement basic circuits using IC (OPAMP and 555 timers).
CO 5	Simulate electronic circuits using any circuit simulation software.
CO 6	Use PCB layout software for circuit design

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								2			
CO 2	2	2	2						2			
CO 3	2	2	2						2			
CO 4	2	2	2						2			
CO 5	1	1			3				3			
CO 6	1				3				3			

LIST OF EXPERIMENTS

1. Measurement of current, voltage, frequencyand phase shift of signal in a RC network using oscilloscope.
2. Clipping circuits usingdiodes.
3. Clamping circuits usingdiodes.
4. Design and testing ofsimpleZener voltage regulator.
5. RC coupled amplifier using BJT in CE configuration-Measurement of gain, BW and plotting of frequencyresponse.
6. JFETamplifier-Measurement of gain, BW and plotting of frequencyresponse.
7. Op-amp circuits – Design and set up of invertingand non-inverting amplifier, scale changer, adder, integrator, and differentiator.
8. Op-amps circuits – Scale changer, adder, integrator, and differentiator.
9. Precision rectifierusingOp-amps.
10. Phase shift oscillator usingOp-amps.
11. Wein'sBridgeoscillator using Op-amps.
12. Waveform generation– Square, triangular andsaw tooth waveformgeneration usingOPAMPs.
13. Basic comparator and Schmitt triggercircuits using Op-amp (Use comparator ICs such as LM311).
14. Design and testing of series voltage regulator using Zenerdiode.
15. Astable and Monostable circuit using555IC.
16. RC phase shift oscillator using Op-amp.
17. Introductionto circuit simulation using any circuit simulation software.
18. Introduction to PCB layout software.

Text Books

1. Bell D. A., Electronic Devices and Circuits, Prentice Hall of India, 2007.
2. Malvino A. and D. J. Bates, Electronic Principles7/e, Tata McGraw Hill, 2010.
3. Boylestad R. L. and L. Nashelsky, Electronic Devices and Circuit Theory, 10/e, Pearson Education India, 2009.
4. Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.

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2. Robert T. Paynter and John Clemons, Paynter's Introductory electronic devices & circuits, Prentice Hall Career & Technology, New Jersey.
3. Millman J. and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw-Hill, 2010.
4. Gayakward R. A., Op-Amps and Linear Integrated Circuits, PHI Learning Pvt. Ltd., 2012.

Course Project: Students have to do a mandatory course project (group size not more than 4 students) using to realise a functional analog circuit on PCB. A maximum of 5 marks shall be awarded for this project (to be evaluated along with the final internal test). Report to be submitted.

Example projects:

1. Audio amplifier.
2. Electronic Pest Repellent Circuit.
3. Electronic Siren.

Assessment Pattern :

Mark distribution :

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Regular Lab work	Internal Test	Course Project	Total
15	30	25	5	75

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 equipment and troubleshooting) : 25 Marks

(d) Viva voce : 20 marks

(e) Record : 5 Marks

General instructions : Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that 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 University examination only on submitting the duly certified record. The external examiner shall endorse the record.

SEMESTER -3

MINOR

Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET281	ELECTRIC CIRCUITS	MINOR	3	1	0	4

Preamble : This course deals with circuit theorems applied to dc and ac electric circuits. Steady and transient state response of electric circuits is discussed. Network analysis is introduced with network parameters and transfer functions. This course serves as the most important prerequisite of all many advanced courses in electrical engineering.

Prerequisite : **Basics of Electrical Engineering / Introduction to Electrical Engineering**

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

CO 1	Apply circuit theorems to simplify and solve DC and AC electric networks.
CO 2	Analyse dynamic DC circuitsand develop the complete response.
CO 3	Analyse coupled circuits in S-domain
CO 4	Analyse three-phase networks in Y and Δ configurations.
CO 5	Develop the representation of two-port networks using Z and Y parameter.

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
CO 4	3	3										2
CO 5	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	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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. State and explain network theorems (K1)
2. Problems on solving circuits using network theorems. (K2, K3)

Course Outcome 2 (CO2):

1. Distinguish between the natural response and forced response. (K2, K3)
2. Problems on steady state and transient analysis of RL, RC and RLC series circuits with DC excitation and initial conditions. (K2, K3)

Course Outcome 3 (CO3):

1. Problems on mesh analysis,analysis of transformed circuits in s-domain (K2, K3).
2. Problems on nodal analysis,analysis of transformed circuits in s-domain (K2, K3).

Course Outcome 4 (CO4):

1. Problems on analysis of balanced Y and Δ configurations. (K2, K3)
2. Problems on analysis of unbalanced Y and Δ configurations. (K2, K3)

Course Outcome 5 (CO5):

1. Problems on finding Z and Y parameters of simple two port networks. (K2).
2. Derive the expression for Z parameters in terms of Y parameters. (K1).

Model Question paper

QP CODE: PAGES: 3

Reg. No:______________

Name:________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET281
Course Name: ELECTRIC CIRCUITS

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions. Each question carries 3 Marks

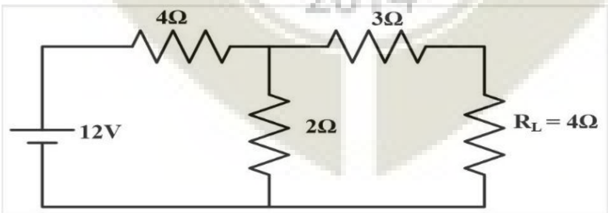
1. Compare the analogy between Nodal and Mesh analysis method.
2. State and explain superposition theorem with suitable examples.
3. Differentiate between transient and steady state analysis.
4. Explain Initial value and final value theorem.
5. Define Self-inductance, Mutual inductance and coupling coefficient.
6. Explain dot rule used in magnetically coupled circuits with the help of a neat figure.
7. Define the terms, real power, reactive power and apparent power.
8. Draw the circuit of a four-wire star connected three phase circuit and mark the lineand phase Voltage.
9. Differentiate driving point and transfer functions with respect to a two port network.
10. Draw the equivalent circuit representation in terms of Z-parameters. **(10 x 3=30)**

PART B

Answer any one full question from each module. Each question carries 14 Marks

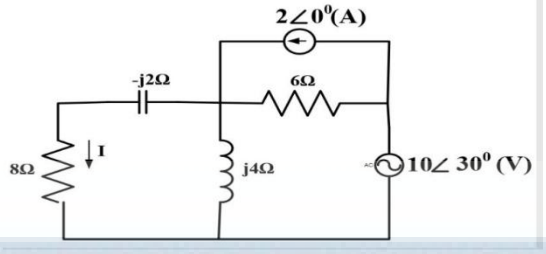
Module-1

11. (a) Draw the Thevenin's equivalent circuit and hence find the power dissipated across R_L **(8)**



(b)Compare the difference between dependent and independent sources. **(6)**

12. (a) Determine the power dissipated across 8Ω for the circuit shown by applying superpositiontheorem. **(10)**



(b) State and explain Thevenin'stheorem with suitable examples. **(4)**

Module-2

13. (a) The current through 5Ω resistor is **I(S) =(5S+3)/(S^2+5S+6).** Find the power dissipated across 5Ω resistor. **(7)**

(b) Derive the equation for the transient current flow through series RL circuit with DCsource and zero initial condition. **(7)**

14. (a) Derive the equation for the transient current flow through series RC circuit with DC source and zero initial condition. **(7)**

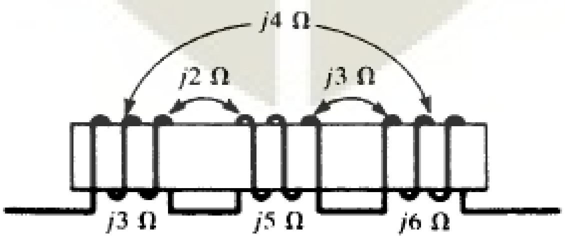
(b) Explain the term time constant with respect to series RL circuit with suitable figures. **(7)**

Module-3

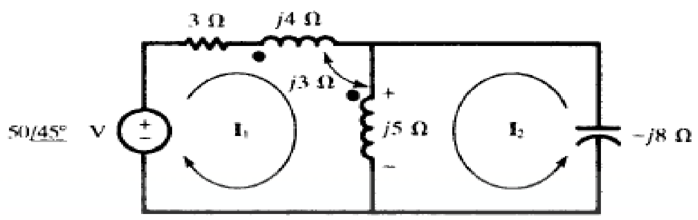
15. (a) In a series aiding connection, two coupled coils have an equivalent inductance LAand in a series opposing connection, the equivalent inductance is LB. Obtain an expression for M in terms of LA and LB. **(7)**

(b) Two coupled coils, L1 = 0.8 H and L2 = 0.2 H, have a coefficient of coupling k = 0:90. Find the mutual inductance M and the turns ratio N1/N2. **(7)**

16. (a) Obtain the dotted equivalent for the circuit shown and use the equivalent to find theequivalent inductive reactance. **(7)**



(b) In the circuit shown in figure, find the voltage across the 5 Ω reactance with the polarity shown. **(7)**



Module-4

17. (a) Explain two watt-meter method to measure the three phase power with the help of suitable equations. **(7)**

(b) Derive the relationship between the line and phase voltage in a three phase starconnected circuit. **(7)**

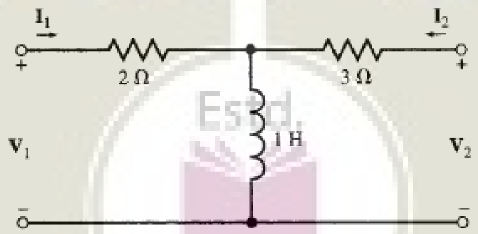
18. (a) A three-phase, three-wire, balanced, delta-connected load yields wattmeter readings of 154W and 557W. Obtain the load impedance, if the line voltage is 141.4 V. **(7)**

(b) Derive the relationship between the line and phase current of a three phase deltaconnected circuit. **(7)**

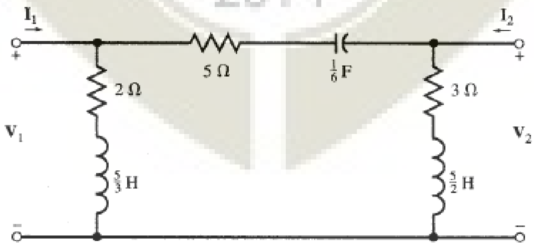
Module-5

19. (a) Derive the relationship between Z and Y parameters. **(6)**

(b) Find the Z-parameters of the two-port circuit. **(8)**



20. (a) Find the Y-parameters of the circuit. **(10)**



(b) Explain the condition for symmetry and reciprocity with respect to Z-parameters. **(4)**

Syllabus

Module 1

Circuit theorems: Review of Nodal and Mesh analysis method. DC and ACcircuits analysis with dependent and independent sources applying Network theorems – Superposition theorem, Thevenin's theorem.

Module 2

Steady state and transient response:Review of Laplace Transforms. DCresponseof RL, RC and RLC series circuitswith initial conditions and complete solution using Laplace Transforms- Time constant.

Module 3

Transformed circuits and analysis – Mutual inductance, coupling coefficient, dot rule. Analysis of coupled coils -– mesh analysis and node analysis of transformed circuits in S-domain.

Module 4

Three phase networks: Three phase power in sinusoidal steady state-complex power, apparent power and power triangle. Steady state analysis of three-phase three-wire and four-wire balanced and unbalanced Y circuits, Balanced and unbalanced Delta circuit. Three phase power measurement and two-wattmeter method.

Module 5

Two port networks: Driving point and transfer functions – Z and Y parameters.- Conditions for symmetry & reciprocity – Z and Y parameters. Relationshipbetween Z and Y parameters.

Text Books

1. Joseph A. Edminister and MahmoodNahvi, "Theory and Problems in Electric circuits", McGraw Hill, 5th Edition, 2010.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References:

21. Hayt and Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, New Delhi, 8th Ed, 2013.
2. Van Valkenberg, "Network Analysis", Prentice Hall India Learning Pvt. Ltd., 3 edition, 1980.
3. K. S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
4. Chakrabarti, "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
5. R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 2010.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Circuit theorems(12 hours)**	
1.1	Review of Nodal analysis method.	2
1.2	Review of Mesh analysis method.	2
1.3	Dependent and independent current and voltage sources	2
1.4	Superposition theorem - Application to the analysis of DCand AC circuits with dependent and independent sources.	3
1.5	Thevenin's theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
2	**Steady state and transient response. (9 hours)**	
2.1	Review of Laplace Transforms – Formulae of Laplace Transforms of common functions/signals, Initial value theorem and final value theorem, Inverse Laplace Transforms – partial fraction method.	3
2.2	DC response of RL series with initial conditions and complete solution using Laplace Transforms- Time constant	2
2.3	DC response of RC series with initial conditions and complete solution using Laplace Transforms- Time constant	2
2.4	DC response of RLC series with initial conditions and complete solution using Laplace Transforms- Time constant	2
3	**Transformed circuits and analysis (8 Hours)**	
3.1	Mutual inductance and Coupling Coefficient	2

3.2	Dot rule and polarity convention	1
3.3	Mesh analysis of transformed circuits in s-domain.	3
3.5	Nodalanalysis of transformed circuits in s-domain.	2
4	**Three phase networks. (9 Hours)**	
4.1	Three phase power in sinusoidal steady state-complex power, apparent power and power triangle.	2
4.2	Steady state analysis of three-phase three-wire and four-wire balanced and unbalanced Y circuits	3
4.3	Steady state analysis of three-phase three-wire and four-wire balanced and unbalanced Delta circuits.	2
4.4	Three phase power measurement and two-wattmeter method.	2
5	**Two port networks (7 Hours)**	
5.1	Two port networks: Terminals and Ports, Driving point and transfer functions.	2
5.2	Z –parameters. Equivalent circuit representation.	1
5.3	Y parameters. Equivalent circuit representation.	1
5.6	Conditions for symmetry & reciprocity- Z and Y-parameters	2
5.7	Relationship between Z and Yparameters.	1

Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET 283	**INTRODUCTION TO POWER ENGINEERING**	**Minor**	**3**	**1**	**0**	**4**

Preamble : This course introduces various conventional energy sources. This course also introduces the design of transmission system and distributions system. It also introduces the economics of power generation.

Prerequisite : EST 130Basics of Electrical & Electronics Engineering

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

CO 1	Illustrate various conventional sources of energy generation
CO 2	Analyse the economics of power generation
CO 3	Analyse the economics of power factor improvement
CO 4	Design mechanical parameters of a transmission system.
CO 5	Design electrical parameters of a transmission system.
CO 6	Classify different types of ac and dc distribution systems.

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
CO 4	3	3										2
CO 5	3	3										2
CO 6	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	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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. Schematic and equipment of Conventional Power generation schemes (K1)
2. Comparison of various turbines associated with conventional generation (K2, K3)

Course Outcome 2 (CO2):

1. Definition and Calculation of various terms associated with power generation (K1, K2)
2. Problems on economics of power generation. (K2, K3)

Course Outcome 3 (CO3):

1. Problems on calculation of size of capacitors for power factor improvement (K2, K3).
2. Problems on economics of power factor placement (K2, K3).

Course Outcome 4 (CO4):

1. Derivation of various mechanical parameters associated with transmission line (K2, K3)
2. Derivation and problems of corona and insulators. (K2, K3).

Course Outcome 5 (CO5):

1. Derivation of various electrical parameters associated with transmission line (K2, K3).
2. Definition on transposition of line and changes in electrical parameters (K1,K2)

Course Outcome 6 (CO6):

1. Problems on AC and DC distribution systems (K2,K3).
2. Architecture and technologies in smart grid (K2,K3)

Model Question paper

QPCODE: PAGES:3

Reg.No:____________

Name :______________

APJABDULKALAMTECHNOLOGICALUNIVERSITY

FIRSTSEMESTERB.TECHDEGREEEXAMINATION, MONTH &YEAR

Course Code: EET 283

Course Name: Introduction to Power Engineering

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. What are the main differences between nuclear and thermal power plants?
2. How are turbines classified? How is a turbine selected for a site?
3. Explain the significance of Load factor and Load curve.
4. Discuss the disadvantages of low power factor in power system.
5. What is corona? Explain the factors have an influence on corona loss
6. High voltage is preferred for transmission. Discuss the merits and demerits of high voltage transmission.
7. Draw and explain the equivalent models of a medium transmission line.
8. What is transposition of lines? Comment on its necessity in the system.
9. Discuss the requirements of a distribution system.
10. Discuss the main features of an interconnected distribution system.

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Explain thegeneral arrangement of gas turbine power plant. **(8)**

    (b) Discuss the importance of small hydro power generation along with their advantages and disadvantages. **(6)**

12. (a) Explain various elements of a elements of diesel power plant **(8)**

(b) Explain the general layout of a nuclear power plant. **(6)**

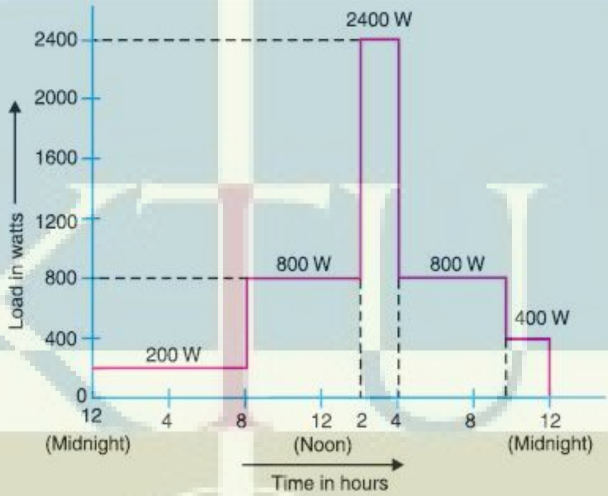
Module 2

13. (a)A generating station has a maximum demand of 150000 kW. The annual load factor is 50% and plant capacity factor is 40%. Determine the reserve capacity of the

plant. **(6)**

(b) The power factor in a three-phase plant with supply voltage of 400 V and absorbing an average power of 300 kW is 0.8. Determine the kVAr of the capacitor required to improve the power factor to 0.93. Determine the reduction in current drawn from the supply after installation of the capacitors. **(8)**

14. (a) Determine average demand and load factor of the load curve shown below **(7)**



(b) Explain any two methods of power factor improvement. **(7)**

Module 3

15. (a) Derive the equation for Sag in transmission lines, when the support is at equaland unequal heights. **(10)**

(b) Discuss the difference between disruptive critical corona and visual critical corona **(4)**

16. (a) In a 33 kV overhead line, there are three units in the string of insulators. If the capacitance between each insulator pin and earth is 11% of self-capacitance of each insulator, find (i) the distribution of voltage over 3 insulators and (ii) string efficiency. **(9)**

(b) Discuss various types of conductors used in power system. **(5)**

Module 4

17. (a) A 3 phase 70km long Transmission line has its conductors of 1 cm diameter spaced at the corners of the equilateral triangle of 100cm side. Find the inductance per phase of the system. **(6)**

(b) Derive loop inductance of a single phase two wire line. **(8)**

18. (a) The three conductors of a 3-phase line are arranged at the corners of a triangleof sides 2 m, 2·5 m and 4·5 m. Calculate the inductance per km of the line when the conductors areregularly transposed. The diameter of each conductor is 1·24 cm. **(6)**

(b)A single-phase transmission line has two parallel conductors 3 m apart,radius of each conductor being 1 cm. Calculate the capacitance of the line per km. **(8)**

Module 5

19. (a) Compare radial and ring main distribution system with the help of appropriate schematics. **(6)**

(b) A two conductor main, AB, 500m in length is fed from both ends at 250 V. Loads of 50A, 60A, 40A and 30A are tapped at distances of 100m, 250m, 350m and 400m from end A respectively. If the cross section of conductor is 1 cm^2 and specific resistance of the material is 1.7 μΩcm, determine the minimum consumer voltage. **(8)**

20. (a) A 2-wire dc distributor cable AB is 2 km long and supplies loads of 100A, 150A,200A and 50A situated 500 m, 1000 m, 1600 m and 2000 m from the feeding point A. Each conductor has a resistance of 0·01 Ω per 1000 m. Calculate the p.d. at each load point if a p.d. of 300 V is maintained at point A. **(7)**

(b) Explain the architecture of smart grid with the help of a schematic **(7)**

(14x5=70)

Syllabus

Module 1

Generation of power

Conventional sources**:** Hydroelectric Power Plants- Selection of site. General arrangement of hydel plant, Components of the plant, Classification of the hydel plants -Water turbines: Pelton wheel, Francis, Kaplan and propeller turbines, Small hydro generation.

Steam Power Plants: Working of steam plant, Power plant equipment and layout, Steam turbines

Diesel Power Plant: Elements of diesel power plant, applications

Gas Turbine Power Plant: Introduction Merits and demerits, selection site, fuels for gas turbines, General arrangement of simple gas turbine power plant, comparison of gas power plant with steam power plants

Nuclear Power Plants:Nuclear reaction, nuclear fission process, nuclear plant layout, Classification of reactors

Module 2

Economics of power generation

Types of loads, Load curve, terms and factors, peak load and base load

Cost of electrical energy – numerical problems

Power factor improvement – causes of low power factor, disadvantages - methods of power factor improvement, calculations of power factor correction, economics of power factor improvement

Module 3

Transmission system

Different types of transmission system - High voltage transmission - advantages

Mechanical design of overhead transmission line: Main components of overhead lines – types of conductors, line supports

Insulators–Types-String efficiency – methods of improving string efficiency

Corona – Critical disruptive voltage - Visual Critical Voltage – corona loss - Factors affecting corona, advantages and disadvantages, methods of reducing corona

Sag - calculation

Module 4

Electrical design of transmission line

Constants of transmission line – Resistance, inductance and capacitance

Inductance and capacitance of a single phase transmission line

Inductance and capacitance of a three phase transmission line with symmetrical and unsymmetrical spacing – transposition of lines

Module 5

Distribution system

Types of distribution systems

Types of DC distributors – calculations – distributor fed at one end and at both ends

Types of AC distributors – calculations

Smart Grid

Smart Grid – Introduction - challenges and benefits — architecture of smart grid introduction to IEC 61850 and smart substation

Text Books

Text Books:

1. D P Kothari and I Nagrath, "Power System Engineering," 2/e Tata McGraw Hills, 2008.
2. Wadhwa, "Electrical Power system", Wiley Eastern Ltd. 2005.

References:

1. A.Chakrabarti, ML.Soni, P.V.Gupta, V .S.Bhatnagar, "A text book of Power system Engineering" DhanpatRai, 2000.
2. Grainer J.J, Stevenson W.D, "Power system Analysis", McGraw Hill.
3. I.J.Nagarath& D.P. Kothari, "Power System Engineering", TMH Publication.
4. A Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Conventional energy sources (9 hours)**	
1.1	Introduction and history ofpower generation	1
1.2	Hydel power plant- Schematic, components and turbines	2
1.2	Steam power plant – Schematic, components and turbines	2
1.3	Schematic and various turbines with diesel and GT power generation	3
1.4	Nuclear power generation	1
2	**Economics of power generation and power factor improvement (8 hours)**	
2.1	Important terms associated with power generation such as load factor, load curve, etc	1

2.2	Numerical problems on the economics of generation.	2
2.3	Significance of power factor in power system	1
2.4	Methods of power factor improvement	2
2.5	Numerical problems on capacitor value evaluation and economics of power factor improvement	2
3	**Transmission System (10 Hours)**	
3.1	Introduction to transmission systems	1
3.2	Mechanical design of transmission lines- line supports and conductors	2
3.3	Types of insulators	1
3.4	String Efficiency, Methods of improving string efficiency, Numerical problems	2
3.5	Corona - Critical disruptive voltage : Visual Critical Voltage –corona loss	1
3.6	Factor affecting corona and corona loss, Numerical problems on corona	2
3.7	Sag in transmission lines	1
4	**Electrical parameters of a transmission line (9 Hours)**	
4.1	Introduction to constants of transmission line	1
4.2	Derivation of inductance and capacitance of a single phase transmission line	2
4.3	Derivation of Inductance and capacitance of a three phase transmission line with symmetrical and unsymmetrical spacing, transposition of lines	3
4..4	Numerical problems on inductance, capacitance of transmission lines	3
5	**Distribution systems (9 Hours)**	
5.1	Introduction to distribution system	1
5.2	DC distribution system – various types	2
5.3	Numerical Examples of DC distribution system	1
5.4	AC distribution system – various types	2
5.5	Numerical Examples of DC distribution system	2
5.6	Introduction to smart grid	1

Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET 285	DYNAMIC CIRCUITS AND SYSTEMS	Minor	3	1	0	4

Preamble : This course introduces the application of circuit analysis techniques to dc and ac electric circuits. Analysis of electric circuits both in steady state and dynamic conditions are discussed. Network analysis using network parameters and transfer functions is also included .

Prerequisite : **Basics of Electrical Engineering / Introduction to Electrical Engineering**

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

CO 1	Apply circuit theorems to simplify and solve complex DC and AC electric networks.
CO 2	Analyse dynamic DC and AC circuits and develop the complete response to excitations.
CO 3	Solve dynamic circuits by applying transformation to s-domain.
CO 4	Solve series /parallel resonant circuits.
CO 5	Develop the representation of two-port networks using network parameters and analyse the network.

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
CO 4	3	3										2
CO 5	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	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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 (CO 1):

1. State and explain network theorems (K1)
2. Problems on solving circuits using network theorems. (K2, K3)

Course Outcome 2 (CO 2):

1. Distinguish between the natural response and forced response. (K2, K3)
2. Problems related to steady state and transient analysis of RL, RC and RLC series circuits with DC excitation and initial conditions. (K2, K3)
3. Problems related to steady state and transient analysis of RL, RC and RLC series circuits with sinusoidal excitation. (K2, K3)

Course Outcome 3 (CO 3):

1. Problems related to mesh analysis and node analysis of transformed circuits in s-domain (K2, K3).
2. Problems related to solution of transformed circuits including mutually coupled circuits in s-domain (K2, K3).

Course Outcome 4 (CO 4):

1. Define Bandwidth, and draw the frequency dependence of impedance of an RLC network. (K1).
2. Develop the impedance/admittance Vs frequency plot for the given RLC network. (K2).
3. Evalutate the parameters such as quality factor, bandwidth,

Course Outcome 5 (CO 5):

1. Problems to find Z, Y, h and T parameters of simple two port networks. (K2).
2. Derive the expression for Z parameters in terms of T parameters. (K1).
3. Show that the overall transmission parameter matrix for cascaded 2 port network is simply the matrix product of transmission parameters for each individual 2 port network in cascade. (K1).

Model Question paper

QP CODE:

PAGES:2

Reg. No:______________
Name:______________

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

Course Code: EET 285
Course Name: DYNAMIC CIRCUITS AND SYSTEMS

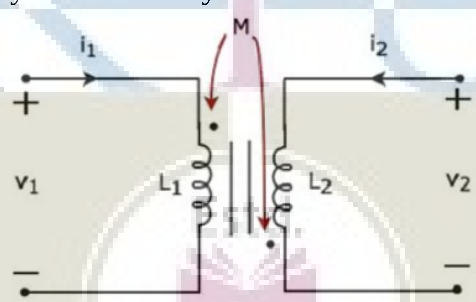
Max. Marks: 100

Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1. What is the condition for transferring maximum power to load in an ac network? How is it obtained?
2. State and explain the reciprocity theorem.
3. Derive an expression for calculating the steady state current when an ac is applied to a series RL circuit.
4. A voltage of $v(t) = 10\cos(1000t + 60^0)$ is applied to a series RLC circuit in which R=10Ω, L=0.02H and C=10^{-4} F. Find the steady current.
5. Apply KVL in both primary and secondary circuits and write the corresponding equations.



6. Give the transform representation in s-domain of an inductor with initial current and transform representation in s-domain of a capacitor with initial voltage.
7. Compare series and parallel resonance on the basis of resonant frequency, impedance and bandwidth.
8. How is selectivity measured in a parallel resonant circuit? How is selectivity increased?
9. What are the conditions for reciprocity of a two port network in terms of z parameters? What are the similar conditions in terms of y parameters?
10. How do we find equivalent T network of a two port network if z parameters are given?

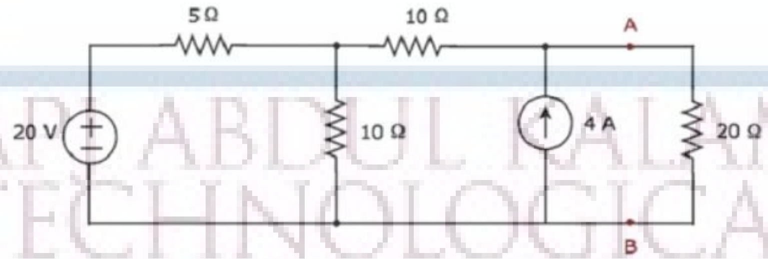
(10 x 3 = 30)

PART B

Answer any one full question, each carries14 marks.

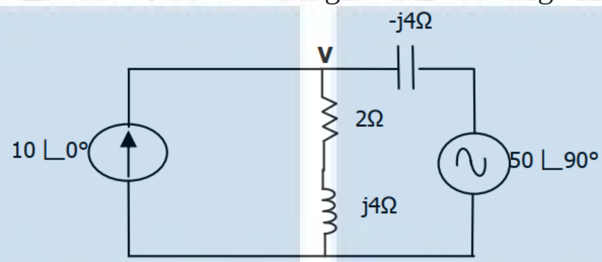
MODULE1

11. a) Find the current through the 20Ω resistor using Norton's theorem. **(6)**



b) State and prove maximum power transfer theorem. **(8)**

12. a) Use superposition theorem to find the voltage V shown in figure. **(8)**



b)State Thevenin's theorem. How is Thevenin equivalent circuit developed? **(6)**

MODULE II

13. a)Write the dynamic equations for analyzing the behavior of step response of a series RLC circuit. **(7)**

b) A sinusoidal voltage 25 sin 10t is applied at time t=0 to a series RL circuit comprising of R=5 Ω, L = 1 H. Using Laplace transformation, find an expression for instantaneous current in the circuit. **(7)**

14. a) A voltage 10 cos (1000t + 60^0) is applied to a series RLC circuit comprising of R=10 Ω, L = 0.02 H, C = 10^{-4} F. Find an expression for the steady state current in the circuit. **(7)**

b) A capacitor C having capacitance of 0.2 F is initially charged to 10 volts and it is connected to an RL series circuit comprising of R=4Ω and L = 1 H, by means of a switch at time t=0. Find the current through the circuit by means of Laplace transformation method. **(7)**

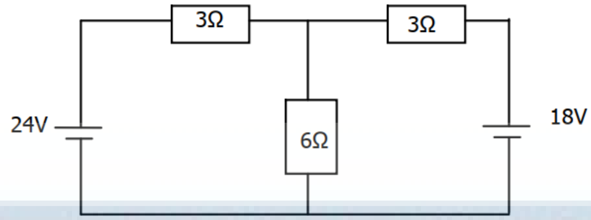
MODULE III

15. a) An LC network comprises of series inductor branches L1 and L2 each of inductance 2 H and parallel capacitor branches C1 and C2 each with capacitance 1 F. Find the transform impedance Z(s). **(6)**

b) What are reciprocal networks? What are the conditions that should be satisfied by a network to be reciprocal? **(8)**

16. a) How is transfer function representation of a network function helpful in analyzing the behavior of the network? Mention the significance of poles and zeros in network functions? **(8)**

b)Using Laplace transformation, find the current in the 6 Ω resistor. **(6)**



MODULE IV

17. a) In a series RLC circuit, for frequencies more than the resonant frequency, what nature of reactance is exhibited? Substantiate the reason for the answer. **(6)**

b) A series RLC circuit consists of R= 25 Ω, L = 0.01 H, C = 0.04 μF. Calculate the resonant frequency. If 10 V is applied to the circuit at resonant frequency, calculate the voltages across L and C. Find the frequencies at which these voltages are maximum. **(8)**

18. a) A coil of resistance 20 ohm and inductance of 200 mH is connected in parallel with a variable capacitor. This combination is connected in series with a resistance of 8000 ohm. Supply voltage is 200 V, 50Hz. Calculate the following

i) The value of C at resonance

ii) The Q of the coil

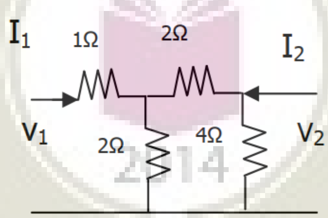
iii) Dynamic resistance of the circuit. **(7)**

b) Derive expressions for selectivity and bandwidth of a parallel tuned circuit. **(7)**

MODULE V

19. a) A two port network has the following z parameters: z_{11}=10 Ω, z_{12}=z_{21}=5 Ω, z_{22} = 12 Ω. Evaluate the y parameters for the network. **(8)**

b)Find the z parameters of the network given. **(6)**



20. a)For the given two-port network equations, draw an equivalent network. $I_1 = 5V_1 – V_2$; $I_2 = -V_2 + V_1$. **(7)**

b) A symmetrical T-network has the following open-circuit and short-circuit impedances:

Z_{oc}= 800Ω (open circuit impedance)

Z_{sc}= 600Ω(short circuit impedance)

Calculate impedance values of the network. **(7)**

Syllabus

Module 1

Circuit theorems: DC and Sinusoidal steady state analysis of circuits with dependent and independent sources applying Superposition principle, Source transformation, Thevenin's, Norton's and Maximum Power Transfer theorems - Reciprocity theorem.

Module 2

Analysis of first and second order dynamic circuits: Formulation of dynamic equations of RL, RC and RLC series and parallel networks with dc excitation and initial conditions and complete solution using Laplace Transforms - Time constant - Complete solution of RL, RC and RLC circuits with sinusoidal excitation using Laplace Transforms – Damping ratio – Over damped, under damped, critically damped and undamped RLC networks.

Module 3

Transformed circuits in s-domain: Transform impedance/admittance of R, L and C - Mesh analysis and node analysis of transformed circuits in s-domain. Transfer Function representation – Poles and zeros.

Analysis of Coupled Circuits: – Dot polarity convention – Sinusoidal steady state analysis of coupled circuits - Linear Transformer as a coupled circuit - Analysis of coupled circuits in s-domain.

Module 4

Resonance in Series and Parallel Circuits:

Resonance in Series and Parallel RLC circuits – Quality factor – Bandwidth – Impedance Vs Frequency, Admittance Vs Frequency, Phase angle Vs frequency for series resonant circuit.

Module 5

Two port networks: Driving point and transfer functions – Z, Y, h and T parameters **-** Conditions for symmetry & reciprocity – relationship between parameter sets – interconnections of two port networks (series, parallel and cascade) — T-π transformation.

Text Books

1. Joseph A. Edminister and MahmoodNahvi, "Theory and Problems in Electric circuits", McGraw Hill, 5th Edition, 2010.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References:

1. Hayt and Kemmerly, “Engineering Circuit Analysis”, McGraw Hill Education, New Delhi, 8th Ed, 2013.
2. Van Valkenberg, "Network Analysis", Prentice Hall India Learning Pvt. Ltd., 3 edition, 1980.
3. K. S. Suresh Kumar, “Electric Circuit Analysis”, Pearson Publications, 2013.
4. Chakrabarti, "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
5. R. Gupta, "Network Analysis and Synthesis", S. Chand & Company Ltd, 2010.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Network theorems - DC and AC steady state analysis (12 hours)**	
1.1	Linearity and Superposition principle - Application to the analysis of DC and AC (sinusoidal excitation) circuits. Application of source transformation in electric circuit analysis.	2
1.2	Thevenin’s theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.3	Norton’s theorem - Application to the analysis of DC and AC circuits with dependent and independent sources.	3
1.4	Maximum power transfer theorem - DC and AC steady state analysis with dependent and independent sources.	2
1.5	Reciprocity Theorem - Application to the analysis of DC and AC Circuits.	2
2	**First order and second order dynamic circuits. (9 hours)**	
2.1	Review of Laplace Transforms – Formulae of Laplace Transforms of common functions/signals, Initial value theorem and final value theorem, Inverse Laplace Transforms – partial fraction method. *(Questions to evaluate the Laplace/inverse transforms of any function / partial fractions method shall not be given in tests/final examination. Problems with application to circuits can be given).*	2
2.2	Formulation of dynamic equations of RL series and parallel networks and solution using Laplace Transforms – with DC excitation and initial conditions. Natural response and forced response. Time constant.	1

2.3	Formulation of dynamic equations of RC series networks and solution using Laplace Transforms – with DC excitation and initial conditions. Natural response and forced response. Time constant.	1
2.4	Formulation of dynamic equations of RLC series networks with DC excitation and initial conditions, and solution using Laplace Transforms – Natural response and forced response. Damping coefficient. Underdamped, Overdamped, critically damped and undamped cases.	1
2.5	Formulation of dynamic equations of RL, RC and RLC series networks and solution with sinusoidal excitation. Complete solution (Solution using Laplace transforms).	2
2.6	Formulation of dynamic equations of RL, RC and RLC parallel networks and solution using Laplace Transforms – with DC and Sinusoidal excitations. Damping ratio.	2
3	**Transformed Circuits in s-domain and Coupled circuits (9 Hours)**	
3.1	Transformed circuits in s-domain: Transformation of elements (R, L, and C) with and without initial conditions.	2
3.2	Mesh analysis of transformed circuits in s-domain.	1
3.3	Node analysis of transformed circuits in s-domain.	1
3.4	Transfer Function representation – Poles and zeros.	1
3.5	Analysis of coupled circuits: mutual inductance – Coupling Coefficient- Dot polarity convention — Conductively coupled equivalent circuits. Linear Transformer as a coupled circuit.	2
3.6	Analysis of coupled circuits in s-domain.	2
4	**Resonance in Series and Parallel Circuits. (6 Hours)**	
4.1	Resonance in Series and Parallel RLC circuits –Related problems	3
4.2	Quality factor – Bandwidth –	1
4.3	Impedance Vs Frequency, Admittance Vs Frequency and Phase angle Vs frequency for series resonant circuit.	2

5	**Two port networks (9 Hours)**	
5.1	Two port networks: Terminals and Ports, Driving point and transfer functions. Voltage transfer ratio, Current transfer ratio, transfer impedance, transfer admittance, poles and zeros.	2
5.2	Z –parameters. Equivalent circuit representation.	1
5.3	Y parameters. Equivalent circuit representation.	1
5.4	h parameters. Equivalent circuit representation.	1
5.5	T parameters.	1
5.6	Conditions for symmetry & reciprocity, relationship between network parameter sets.	1
5.7	Interconnections of two port networks (series, parallel and cascade).	1
5.8	T-π Transformation.	1

SEMESTER -4

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET202	**DC MACHINES AND TRANSFORMERS**	**PCC**	**2**	**2**	**0**	**4**

Preamble : The purpose of the course is to provide the fundamentals of DC generators, DC motors and transformers and giving emphasis to applications in engineering field.

Prerequisite : Basics of Electrical Engineering

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

CO 1	Acquire knowledge about constructional details of DC machines
CO 2	Describe the performance characteristics of DC generators
CO3	Describe the principle of operation of DC motors and select appropriate motor types for different applications
CO 4	Acquire knowledge in testing of DC machines to assess its performance
CO 5	Describe the constructional details and modes of operation of single phase and three phase transformers
CO6	Analyse the performance of transformers under various conditions

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	2			2							3
CO 2	3	2				2						3
CO 3	3	2	2			2						3
CO4	3	3				2						3
CO5	3					2						3
CO6	3					2						3

Assessment Pattern

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

Part A: 10 Questions x 5 marks=50 marks, **Part B:** 5 Questions x 10 marks =50 marks

Course Level Assessment Questions

CO1:

1. Describe the functions of individual parts of DC machines.
2. Develop simplex lap and wave windings for different pole and slot configurations.
3. Explain in detail why equaliser rings are required in lap windings.

CO2:

1. Describe different types of DC generators.
2. Derive the EMF equation of a DC machine.
3. Draw the open circuit and load characteristics of DC generators.
4. Explain the condition for voltage build up.
5. Explain armature reaction in DC machines and solutions to overcome its effects.
6. Analyse parallel operation of DC generators.

CO3:

1. Derive the torque equation of a DC motor.
2. Why starters are used in DC motors?
3. Explain types of speed control in DC motor.
4. Explain regenerative braking in DC motor.
5. What are the losses associated with DC motor?
6. Select suitable type of DC motor for specific applications.

CO4:

1. Describe the principle of Swinburn’s test for testing of DC motor and perform the calculations.
2. Describe the principle of Hopkinson’s test for testing of DC motor.
3. Describe the principle of retardation test for separation of losses in a DC motor.

CO5:

1. Derive the EMF equation of single-phase transformer.
2. Derive the condition for maximum efficiency in a transformer.
3. Explain the difference between power transformer and distribution transformer.
4. Explain the current rating and kVA rating of auto transformers.
5. Explain in detail no load and on load tap changing.
6. Draw the various three phase transformer connections.
7. Explain the stabilization by tertiary winding.

CO6:

1. Draw the equivalent circuit of single-phase transformer referred to primary side.
2. Explain no load and short circuit test on a single-phase transformer.
3. Explain Sumpner's test on transformers.
4. What are the necessary condition for parallel operation of a single phase and three phase transformers?

Model Question paper

QP CODE:

PAGES: 2

Reg. No:______________
Name:________________

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

Course Code: EET 202

Course Name: DC MACHINES AND TRANSFORMERS

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

PART A

Answer all questions. Each Question Carries 3 marks

1. Compare Lap and Wave Windings in DC machines.
2. Explain the need of Dummy Coils in DC machines.
3. What is armature reaction and mention two methods to eliminate it in DC machines.
4. What are the necessary conditions for voltage build up in a DC shunt generator.
5. Explain the significance of Back emf in a DC motor. Write down the voltage equation of a DC shunt motor.
6. Discuss the different types of armature speed control in DC shunt motor.
7. Derive the emf equation for a single phase Transformer.
8. How the rating of a transformer is specified? Justify.
9. Discuss the operation of open delta (V-V) configuration of transformers.
10. Discuss the need and working of on-load tap changers.

PART B

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

Module 1

11. a) Discuss the need of Equalizer rings. **(5)**
    b) Obtain the front and back pitch of a progressive simplex double layer wave winding for a 4 pole dc generator with 30 armature conductors. **(9)**
12. Explain the construction of a DC machine with neat diagram. **(14)**

Module 2

13. Explain different types of DC generator with neat circuit diagram and necessary equations. **(14)**
14. Two DC shunt generators with induced emfs of 120V and 115V, armature resistance of 0.05Ω and 0.04Ω and field resistances of 20Ω and 25Ω respectively are in parallel supplying a total load of 25kW. Calculate the load shared by each generator? **(14)**

Module 3

15. Draw the circuit diagram and explain the experimental procedure to conduct Hopkinson test on DC machine. **(14)**
16. A DC machine is rated at 5kW, 250V, 2000rpm and Ra=1Ω. Driven at 2000rpm, the no load power input to the armature is 1.2A at 250V with field winding (Rsh) = 250Ω, excited by Ish =1A. (i) Estimate efficiency as a generator delivering. (ii) Estimate the efficiency as a motor taking 5kW from supply. **(14)**

Module 4

17. a) Derive the condition for maximum efficiency and the load current at which max. Efficiency occurs in a single phase transformer. **(8)**

    b) Discuss the significance of all day efficiency of transformers. **(6)**

18. A 20kVA, 250/2500V single phase transformer gave the following test results.

    OC Test (LV side): 200V, 1.4A, 105W

    SC Test (HV side): 120V, 8A, 320W

    Draw the equivalent circuit of single phase transformer referred to LV side. **(14)**

Module 5

19. Explain Auto transformer with neat diagram and Derive an expression to justify thesaving of copper in auto transformer with respect to an ordinary two winding transformer with same rating. **(14)**
20. Explain Dy11 and Yd1 vector groupings of three phase transformers with phasor and winding connection diagrams. **(14)**

Syllabus

Module 1

Constructional details of dc machines - armature winding- single layer winding, double layer winding- lap and wave, equalizer rings, dummy coils, MMF of a winding, EMF developed, electromagnetic torque - numerical problems.

Module 2

DC generator –principle of operation, EMF equation, excitation,armature reaction– demagnetising and cross magnetising ampere turn,compensating windings, interpoles, commutation,OCC, voltage build upand load characteristics, parallel operation. Power flow diagram– numerical problems.

Module 3

DC motor –back emf, generation of torque,torque equation,performance characteristics – numerical problems.

Starting of dc motors- starters –3point and 4 point starters(principle only).

Speed control of dc motors - field control, armature control. Braking of dc motors. Power flow diagram – losses and efficiency.Testing of dc motors - Swinburne's test,Hopkinson's test, and retardation test.DC motor applications – numerical problems.

Module 4

Single phase transformers –constructional details, principle of operation, EMF equation, ideal transformer,dot convention, magnetising current, transformation ratio, phasor diagram, operation on no load and on load, equivalent circuit, percentage and per unit impedance, voltage regulation. Transformer losses and efficiency, condition for maximum efficiency,kVA rating. Testing of transformers– polarity test, open circuit test, short circuit test, Sumpner's test – separation of losses, all day efficiency.Parallel operation of single-phase transformers– numerical problems

Module 5

Autotransformer – saving of copper –ratingof autotransformers.

Three phase transformer – construction- difference between power transformer and distributiontransformer –Different connections of 3-phase transformers. Y-Y, Δ-Δ,Y-Δ, Δ-Y, V-V. Vector groupings – Yy0, Dd0, Yd1, Yd11, Dy1, Dy11.Parallel operation of three phase transformers.

Three winding transformer – stabilization by tertiary winding. Tap changing transformers - no load tap changing, on load tap changing, dry type transformers.

Text Books

1. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D. P. Kothari, Theory of AC Machines, Tata McGraw Hill, 2017.

Reference Books

1. Fitzgerald A. E., C. Kingsley and S. Umans, Electric Machinery, 6/e, McGraw Hill, 2003.
2. Langsdorf M. N., Theory of Alternating Current Machinery, Tata McGraw Hill, 2001.
3. Deshpande M. V., Electrical Machines, Prentice Hall India, New Delhi, 2011.
4. B. L. Theraja, Electrical Technology Vol II,S.Chand Publications.
5. A. E. Clayton & N. N. Hancock, The Performance and design of Direct Current Machines,CBS Publishers& Distributors, NewDelhi.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Hours
1	**Constructional details of dc machines**	**8**
1.1	Constructional details of DC machines	2
1.2	Armature winding- single layer	1
1.3	Armature winding- double layer-wave and lap, equaliser rings, dummy coils.	3
1.4	MMF of a winding, EMF developed, electromagnetic torque.	2
2	**DC Generator**	**9**
2.1	DC generators- principle of operation, EMF equation, methods of excitation –separately and self-excited – shunt, series, compound machines.Numerical problems	3
2.2	Armature reaction – effects of armature reaction, demagnetising and cross magnetising ampere-turns, compensating windings,interpoles. Numerical problems.	3
2.3	Load characteristics, losses and efficiency power flow diagram. Parallel operation – applications of dc generators. Numerical problems.	3
3	**DC Motor**	**10**
3.1	DC motor– principle of operation, back emf, classification– torque equation. Numerical problems.	2

3.2	Starting of DC motors – necessity of starters. Numerical problems. Types of starters – 3 point and 4 point starters(principle only).	2
3.3	Speed control – field control, armature control- Numerical problems. Braking of dc motors (Description only)	2
3.4	Losses and efficiency – power flow diagram. Numerical problems	1
3.5	Swinburne's test - Numerical problems.	1
3.6	Hopkinson's test, separation of losses – retardation test. Applications of dc motors.	2
4	**Single phase Transformer**	**10**
4.1	Transformers – principle of operation, construction, core type and shell type construction.	1
4.2	EMF equation, transformation ratio, ideal transformer,transformer with losses, phasor diagram - no load and on load operation. Numerical problems.	2
4.3	Equivalent circuit, percentage and per unit impedance, voltage regulation. Numerical problems.	2
4.4	Transformer losses and efficiency, Condition for maximum efficiency, all day efficiency – Numerical problems.	2
4.5	Dot convention – polarity test, OC & SC test, Sumpner's test,separation of losses. Numerical problems.	2
4.6	kVA rating of transformers,parallel operation of single phase transformers	1
5	**Autotransformer & Three phase transformer**	8
5.1	Autotransformer – ratings, saving of copper.Numerical problems.	2
5.2	Three phase transformer construction, three phase transformer connections, power transformer and distribution transformer.	2
5.3	Vector groupings Yy0, Dd0, Yd1, Yd11, Dy1, Dy11.	1
5.4	Three winding transformer – tertiary winding. Percentage and per unit impedance. Parallel operation.	2
5.5	On load and off load tap changers, dry type transformers.	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET204	**ELECTROMAGNETIC THEORY**	PCC	3	1	0	4

Preamble : The purpose of the course is to familiarize the students with the fundamentals of electrostatics, magnetostatics, time-varying fields and electromagnetic waves.

Prerequisite : Engineering Mathematics,Engineering Physics

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

CO 1	Apply vector analysis and coordinate systems to solve static electric and magneticfield problems.
CO 2	Apply Gauss Law, Coulomb's law and Poisson's equation to determine electrostatic field parameters
CO 3	Determine magnetic fields from current distributions by applying Biot-Savart's law and Amperes Circulal law.
CO 4	Apply Maxwell Equations for the solution of timevarying fields
CO 5	Analyse electromagnetic wave propagation in different media.

Mapping of course outcomes with programme 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										
CO 2	2	3										
CO 3	2	3										
CO 4	2	3										
CO 5	2	3										

Assessment Pattern:

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

*Numerical problems to test the understanding and application of principles to be asked.

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. Transform the vector **B**= 5$\mathbf{a}_x$-7$\mathbf{a}_y$ to Cylindrical Co-ordinate System at the point P (r=4, Φ=120^o, z=2).
2. Drawing necessary sketches, obtain the rectangular co-ordinates x,y,z of the point P , in terms of its cylindrical co-ordinates r,Φ,z. Assume the same origin for both co-ordinate systems.
3. Distinguish between Divergence and Gradient. Explain the physical significance of Divergence.
4. State and prove Divergence Theorem.

Course Outcome 2 (CO2):

1. A 2μC positive charge is located in vacuum at P_1(3,-2,4) and 5μC negative charge is at P_2 (1,-4,-2). Determine: (i) the vector force on the negative charge. (ii) the magnitude of the force on the charge at P_1?
2. Apply Gauss's Law to obtain the electric field intensity due to an infinite sheet of charge.
3. Derive an expression for the capacitance of a co-axial cable.

Course Outcome 3(CO3):

1. Derive the magnetic field intensity at a point on a line through the centre and perpendicular to the plane of a circular loop of radius 'r' m carrying current 'I' A. The point is at a distance 'h' m from the centre of the loop.
2. State Ampere's Circuital law. Express it in integral and differential forms.
3. State Biot-Savart's Law and express it in vector form.

Course Outcome 4 (CO4):

1. Formulate the Maxwell's equation in differential form and integral form for time-varying fields.
2. Derive general wave equations from Maxwell's equations.
3. Explain how Ampere's circuital law can be modified for time-varying fields.

Course Outcome 5 (CO5):

1. Define a) intrinsic impedance b) characteristic impedance.
2. Derive wave equations for Uniform plane wave in free space.
3. A 9375 MHz uniform plane wave is propagating in free space. If the amplitude of the electric field intensity is 20 V/m and the material is assumed to be loss less find α, β, λ, intrinsic impedance, propagation constant and amplitude of magnetic field intensity.

Model Question paper

PAGES: 2

QP CODE:

Reg. No:______________

Name :______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FOURTH SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EET 204

Course Name: ELECTROMAGNETIC THEORY

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. State Strokes Theorem and explain.
2. What do you understand by Curl of a vector? Explain its physical significance?
3. Define electric dipole. What is the electric field intensity due to an electric dipole?
4. Explain the term electric field intensity.
5. State Biot-Savarts Law.
6. What is conduction current and displacement current?
7. Explain group velocity and phase velocity.
8. Which of Maxwell's equation states that the magnetic field is a non-conservational field in both static and dynamic conditions? Comment.
9. Explain electromagnetic interference.
10. What is SWR?

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Transform vector A= 5 a$\hat{r}$ + 2 sinϕa$\hat{\theta}$ +2 cosθ a$\hat{\phi}$ in spherical to Cartesian coordinate system. **(6)**

(b) Evaluate both sides of the Divergence theorem for the region r ≤ 1 and if A= 3r $sin^2\theta$ $cos^2\phi$ a$\hat{r}$. **(8)**

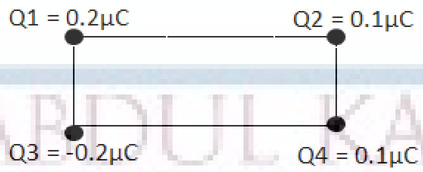
12. (a) Derive co-ordinate transformation between Cartesian and Spherical systems. **(10)**

(b) Explain the physical significance of divergence of a vector field. **(4)**

Module 2

13. (a) State and Prove Gauss's Law. **(4)**

(b) Four point charges are located at the four corners of the rectangle as shown. Length and breadth of rectangle are 5cm and 2 cm respectively. Find the magnitude and direction of the resultant force on Q1. **(10)**



14. (a) Derive the expression of electric field intensity due to infinite line charge having line charge density ρ C/m. **(6)**

(b) Using Gauss's Law derive an expression for the capacitance per unit length between two infinitely long concentric conducting cylinders. The medium between two cylinders is completely filled with air. **(8)**

Module 3

15. (a) State the boundary conditions at the boundary of two magnetic media of permeability μ1 and μ2. **(10)**

(b) Flux lines are received at an iron-air boundary at88^0. If the iron has a relative permeability of 350, determine the angle from the normal with which the flux emerges into air. **(4)**

16. (a) Find the incremental contribution ΔH to magnetic field intensity at the origin caused by a current element in free space, IdL equal to $3\pi\, a\hat{z}$nA, located at (3,-4,0). **(8)**

(b) Derive the magnetic field intensity on the axis of a circular loop carrying current. **(6)**

Module 4

17. (a) A 10GHz plane wave travelling in free space has an amplitude 15V/m. Find velocity of propagation, wavelength, amplitude of H, characteristic impedance of media, propagation constant. **(10)**

(b) What is skin effect and skin depth? (4)

18. (a) Explain about Poynting Theorem. Show that the power flow along a concentric cable is the product of voltage and current using pointing Theorem. **(10)**

(b) What is uniform plane wave? What are its properties? **(4)**

Module 5

19. (a) Explain in detail impedance matching of lines. **(10)**

(b) Explain the term propagation constant and phase velocity as applied to transmission lines. **(4)**

20. (a) Derive the basic transmission line equation. **(9)**

(b) What are the different parameters of transmission lines? **(5)**

Syllabus

Module 1:

Introduction to Co-ordinate Systems – Rectangular, Cylindrical and Spherical Co- ordinate Systems – Co-ordinate transformation; Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field- their physical interpretation; Divergence Theorem, Stokes' Theorem;

Module 2:

Coulomb's Law, Electric field intensity, Field due to a line charge, surface charge distribution. Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite line charge, infinite sheet charge; Electric Potential-Potential Gradient, conservative property of electric field, Equipotential surfaces; Electric Dipole; Capacitance - capacitance of co-axial cable, two wire line; Poisson's and Laplace's equations;

Module 3:

Biot-Savart's Law, Magnetic Field intensity due to a finite and infinite wire carrying current; Magnetic field intensity on the axis of a circular and rectangular loop carrying current; Magnetic flux Density; Magnetic Vector Potential; Ampere's circuital law and simple applications; Inductance and mutual inductance. Boundary conditions for electric fields and magnetic fields;

Conduction current and displacement current densities; Continuity equation for current; Maxwell's Equation in Differential and Integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss's Law.

Module 4:

Wave Equations from Maxwell's Equations; Uniform Plane Waves, Wave equations in Phasor form; Propagation of Uniform Plane waves in free space, loss-less and lossy dielectric medium, Uniform Plane waves in good conductor; Skin effect and skin depth, phase velocity and groupvelocity, Intrinsic Impedance, Attenuation constant and Propagation Constant in all medium;Poynting Vector and Poynting Theorem.

Module 5:

Transmission line: Waves in transmission line, Line parameters, Transmission line equation & solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Standing Wave Ratio(SWR), impedance matching.Solution of problems. Electromagnetic interference.

Text Books

1. Matthew N.O. Sadiku, *Principles of Electromagnetics*, Oxford University Press, 6th Edition.

2 Hayt W. H. and J. A. Buck, *Engineering Electromagnetics*, McGraw-Hill, 8th Edition.

Reference Books

1 Joseph A. Edminister, *Electromagnetics, Schaum's Outline Series*, Tata McGraw-Hill, Revised 2nd Edition.

2 John Kraus and Daniel Fleisch, *Electromagnetics with Applications*, McGraw-Hill, 5th edition

3 Cheng D K, *Fundamentals of Engineering Electromagnetics*, Addison-Wesley.

4 Guru B. S. and H. R.Hizroglu, *Electromagnetic Field Theory Fundamentals*, PWS Publication Company, Boston, 1998.

5 Gangadhar K. A. and P. M. Ramanathan, *Electromagnetic Field Theory*, Khanna Publishers, 2009

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1:**	**9**
1.1	Introduction to coordinate systems – Rectangular, cylindrical and spherical coordinate Systems – Coordinate transformation. Numerical Problems.	3
1.2	Gradient of a scalar field, Divergence of a vector field and curl of a vector field- physical interpretation. Numerical Problems.	3
1.3	Divergence Theorem, Stokes' Theorem.Numerical Problems.	3
2	**Module 2:**	**9**
2.1	Coulomb's Law, Electric field intensity, Field due to a line charge, surface charge distribution. Numerical Problems.	2
2.2	Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite line charge, Infinite sheet charge. Numerical problems.	3

2.3	Electric Potential-Potential Gradient, conservative property of electric field, Equipotential surfaces. Numerical Problems.	2
2.4	Electric Dipole, Capacitance, Poisson's and Laplace's equations.Numerical Problems.	2
3	**Module 3:**	**11**
3.1	Biot-Savart's Law, Magnetic Field intensity due to a finite and infinite wire carrying current.Magnetic field intensity on the axis of a circular and rectangular loop carrying current.Numerical Problems.	3
3.2	Magnetic flux Density; Magnetic Vector Potential; Ampere's circuital law and simple applications, Numerical Problems.	3
3.3	Boundary conditions for electric fields and magnetic fields. Conduction current and displacement current densities; Continuity equation for current; Electrostatic Energy Density.; Numerical Problems.	3
3.5	Maxwell's Equation in Differential and Integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss's Law; Numerical Problems.	2
4	**Module 4:**	8
4.1	Wave Equations from Maxwell's Equations; Uniform Plane Waves, Wave equations in Phasor form. Numerical Problems.	3
4.2	Propagation of Uniform Plane waves in free space, loss-less and lossy dielectric medium, Uniform Plane waves in good conductor-properties in different medium.Numerical Problems.	3
4.3	Skin effect and skin depth, Poynting Vector and Poynting Theorem. Numerical Problems.	2
5	**Module 5:**	8
5.1	Transmission line: Waves in transmission line, Line parameters.Numerical Problems.	3
5.2	Transmission line equation &solutions, Physical significance of solutions,Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation.Numerical Problems.	3
5.3	SWR, impedance matching .Solution of problems. Electromagnetic interference Solution of problems.	2

.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET206	**DIGITAL ELECTRONICS**	PCC	3	1	0	4

Preamble : **Nil**

Prerequisite : **Nil**

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

CO 1	Identify various number systems, binary codes and formulate digital functions using Boolean algebra.
CO 2	Design and implement combinational logiccircuits.
CO 3	Design and implement sequential logic circuits.
CO 4	Compare the operation of various analog to digital and digital to analog conversion circuits.
CO 5	Explain the basic concepts of programmable logic devices and VHDL.

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Convert one number system to another form.-Binary, decimal, octal and hexadecimal
2. Arithmetic’s using of a 2’s complement method?
3. Binary and BCD arithmetic’s.
4. Reduce the Boolean expression.
5. Develop logiccircuits using Universal gates.
6. Reduce the Boolean expression using Boolean laws.
7. Describe the logic levels used in TTL logic system.

Course Outcome 2 (CO2):

1. Convert an SOP form to a POS form and vice-versa?
1. Boolean expression simplification using K map.
2. Design full adder using NAND gates alone.
3. Draw and explain the circuit of carry look ahead adder circuit.
4. Discusshow the look ahead carry adder speed up the addition process?
5. Design of i)Half adder ii) Full adder iii) Full subtractor using gates

6. Differentiate priority encoder andordinaryencoder.
7. Explain the use of the enable input in a decoder?
8. Explain odd parity generator and even parity generator.
9. Differentiate between Multiplexers and De- Multiplexers.
10. Design an 8421 to 2421 BCD code converter and draw its logic diagram.

Course Outcome 3(CO3):

1. Explain different types of flip-flops and its application areas.
2. Design various counter circuits.
3. Describe a level triggered flipflopand compare it with an edge triggered flipflop?
4. Discuss master slave flipflop?
5. Design a mod-7 asynchronous counter using J-K flipflop.
6. Distinguish ring counter from Johnson counter.
7. Explain various types of shift register?
8. Differentiate between a counter and a shift register?

Course Outcome 4 (CO4):

1. Determine the number of output voltages that can be produced by an 8 bit ADC.
2. Write the advantage of the R-2R ladder DAC over the weighted resistor type DAC?
3. Which one is the fastest ADC and explain why?
4. Compare PLA and PAL?
5. Describe programmable logic array and differentiate it from ROM?

Course Outcome 5 (CO5):

1. Differentiate between Moore and Mealy machine?
2. Explain the function of mealy machine
3. Code implementation of simple circuits using Verilog
4. Explain FPGA and state its applications?

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

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.

Model Question Paper

QP Code: Pages: 2

Reg No: ___________________

Name: ____________________

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

Course Code: EET 206
Course Name: DIGITAL ELECTRONICS

Max. Marks: 100 Duration: 3 Hours

PART A
Answer all Questions. Each question carries 3 Marks

1. Translate the gray code 10110010101 to binary number.
2. Express the decimal number -31 as an 8 bit binary number in sign magnitude form, 1's complement form and 2's complement form.
3. Simplify the Boolean expression $AB + \overline{AC} + A\bar{B}C(AB + C)$.
4. Develop the standard Sum of Products(SOP) for the logic expression $F(A, B, C, D) = AB + \bar{A}B\bar{D} + B\bar{C}D$
5. Differentiate between Multiplexers and De- Multiplexers.
6. Realize a 2-bit comparator.
7. How does a J-K Flip Flop differ from an S-R Flip Flop in its operation?
8. What are PRESET and CLEAR inputs?
9. Draw the schematic of a successive approximation A/D converter.
10. Differentiate PLA and PAL circuits **(10 x 3 = 30)**

PART B
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Why is two's - complement method of representing signed integer numbers preferred overones complement in digital circuits? What is range of numbers that can be represented using two's complement with four bits? **(10)**

 (b) Represent the decimal number 3.248×10^4 in single precision IEEE binary format **(4)**

12. (a) Explain the working of a TTL NAND gate with the help of internal diagram. **(10)**

 (b) Compare CMOS and TTL performance. **(4)**

Module 2

13. (a) Make use of a 4 variable K map and simplify $F(A,B,C,D) = \sum_m$ *(1,4,9,10,11,12,14) + d(0,8,13)*. Realize the function using NAND gates only. **(10)**

(b) Design a half adder circuit and realize using NAND gates only. **(4)**

14. (a) Realize a look-ahead-carry adder. **(8)**

(b) Construct the truth table for a full adder. Reduce it using K map. Implement it using logic gates. **(6)**

Module 3

15. (a) Explain the even parity method for error detection. **(8)**

(b) Use a 4 x 1 MUX to implement the logic function $F(A,B,C) = \sum_m(1,2,4,7)$. **(6)**

16. (a) What is the purpose of decoder? Explain the functioning of a BCD to Decimal Decoder circuit. **(8)**

(b) Explain the architecture of ALU with the help of a block diagram **(6)**

Module 4

17. (a) Realize an S-R flip flop using a D flipflop. **(10)**

(b) What is the race around condition of a J-K flip flop? How can it be avoided? **(4)**

18. (a) Design a Synchronous Mod-6 Counter using J-K FFs **(8)**

(b) Draw a parallel in -serial out (PISO) register and explain its working. **(6)**

Module 5

19. (a) Differentiate between Moore and Mealy machine? Compare them with the help of logic diagrams. **(10)**

(b) What is the advantage of the R-2R ladder DAC over the weighted resistor type DAC? **(4)**

20. (a) Explain FPGA and state its applications? **(8)**

(b) Design and implement a half adder using Verilog. **(6)**

Syllabus

Module 1

Number Systems and Codes: Binary, Octal and hexadecimal conversions- ASCII code, Excess -3 code, Gray code, BCD, Error detection codes-Parity method.

Signed numbers- representation, addition and subtraction,Fixed point and floating-point representation.

Logic gates, Universal gates, TTL and CMOS logic families-Internal diagram of TTL NAND gate and CMOS NOR gate. Comparison of CMOS and TTL performance.

Module 2

Boolean Laws and theorems, Sum of Products method, Product of Sum method – K map representation and simplification(up to four variables) - Pairs, Quads, Octets, Don't care conditions.

Combinational circuits: Adders -Full adder and half adder, Subtractors- halfsubtractor and fullsubtractor, 4 bit parallel binary adder/subtractor, Carry Look ahead adders.

Module 3

Comparators, Parity generators and checkers, Encoders, Decoders, , BCD to seven segment decoder, Code converters, Multiplexers, Demultiplexers, Architecture of Arithmetic Logic Units (Block schematic only).

Module 4

Flip-Flops, SR, JK, D and T flip-flops, JK Master Slave Flip-flop, Preset and clear inputs, Conversion of flip-flops.

Registers -SISO, SIPO, PISO, PIPO.

Up/Down Counters: Asynchronous Counters – Modulus of a counter – Mod-N counters Ring counter, Johnson Counter

Synchronous counters,Design of Synchronous counters.

Module 5

State Machines: State transition diagram, Moore and Mealy Machines

Digital to Analog converter –Specifications, Weighted resistor type, R-2R Ladder type.Analog to Digital Converter – Specifications, Flash type, Successive approximation type.

Programmable Logic Devices - PAL, PLA, FPGA (Introduction and basic concepts only)
Introduction to Verilog, Implementation of AND, OR, half adder and full adder.
Note: Course assignments may be given in Verilog programming

Text Books

1. Floyd T.L, Digital Fundamentals, 10/e, Pearson Education, 2011.
2. C.H.Roth and L.L.Kimney Fundamentals of Logic Design, 7/e, Cengage Learning, 2013.
3. Mano M.M, Logic and Computer Design Fundamentals, 4/e, Pearson Education.
4. A Anand Kumar, Fundamental of Digital Electronics ,Prentice Hall
5. Roy Chaudari ,Linear Integrated Circuits, New Age International Publications
6. S. Salivahanan , Digital Circuits and Design, Oxford University Press

Reference Books

1. Donald P. Leach, Albert Paul Malvino and GoutamSaha, Digital Principles and Applications, 8/e, by McGraw Hill.
2. Tocci R.J. and N.S.Widmer, Digital Systems, Principles and Applications, 11/e, Pearson Education.
3. John F. Wakerly, Digital Design: Principles and Practices, 4/e, Pearson, 2005.
4. Taub& Schilling: Digital Integrated Electronics, McGraw Hill, 1997.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Number systems and Binary codes10**	
1.1	Introduction, Binary, Octal and hexadecimal conversions	2
1.2	ASCII code, Excess -3 code, Gray code, BCD.	1
1.3	Error detection codes –Parity Codes.	1
1.4	Signed numbersrepresentation, addition and subtraction	1
1.5	Fixed point and floating-point representation	2
1.6	Logic gates and universal gates	1
1.7	TTL and CMOS logic families-Internal diagram of TTL NAND gate and CMOS NOR gate. Comparison of CMOS and TTL performance.	2
2	**Boolean Algebra and Adders9**	
2.1	Boolean Laws and theorems.	1
2.2	Standard forms and canonical forms, Sum of Products method, Product of Sums method.	2
2.3	K-map representation and simplification (upto four variables) -Pairs, Quads, Octets, Don't care conditions. Realisation using universal gates.	2
2.4	Adders - Full adder and half adder – Subtractors, half subtractor and full subtractor.	2
2.5	4-bit parallel binary adder/subtractor.	1
2.6	Carry Look-ahead adders.	1

3	**Combinational Logic Circuits**	**9**
3.1	2- and 4-bit magnitude comparator.	2
3.2	Parity generators and checkers.	1
3.3	Encoder, Decoder-BCD to decimal and BCD to seven segment decoders.	2
3.4	Realisation of Code converters.	1
3.5	Multiplexers and implementation of functions, Demultiplexers	2
3.6	Architecture of Arithmetic Logic Units (Block schematic only)	1
4	**Sequential circuits10**	
4.1	Flip-Flops, SR, JK, D and T flip-flops, JK Master Slave Flip-flop, Preset and clear inputs	2
4.2	Conversion of flip-flops.	2
4.3	Registers -SISO, SIPO, PISO, PIPO.	1
4.4	Up/Down Counters: Asynchronous Counters – Modulus of a counter – Mod-N counters.	2
4.5	Ring counter, Johnson Counter.	1
4.6	Design of Synchronous counters	2
5	**State Machines, D/A and A/D converters and PLDs7**	
5.1	State Machines: State transition diagram, Moore and Mealy Machines	1
5.2	Digital to Analog converter – R-2R ladder, weighted resistors.	1
5.3	Analog to Digital Converter - Flash ADC, Successive approximation.	1
5.4	Programmable Logic Devices - PAL, PLA-function implementation - FPGA (Introduction and basic concepts only).	2
5.5	Introduction to VHDL, Implementation of AND, OR, half adder and full adder.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EEL202	**ELECTRICAL MACHINES LAB I**	**PCC**	**0**	**0**	**3**	**2**

Preamble : The purpose of this lab is to provide practical experience in operation and testing of DC machines and transformers.

Note : A minimum of **TWELVE** experiments are mandatory out of the fifteen listed.

Prerequisite :

1. Fundamentals of Electrical Engineering
2. D.C Machines and Transformers (Theory)

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

CO 1	Analyse the performance of DC motors and DC generators by performing load test.
CO 2	Sketch the Open Circuit Characteristics of a self excited DC shunt generator and check conditions of voltage build up by performing suitable experiment.
CO 3	Develop equivalent circuit and predetermine their regulation and efficiency by performing OC & SC tests on transformer.
CO 4	Analyse the efficiency and regulation of the transformer by performing load test.
CO 5	Analyse the efficiency of a DC machine when working as motor and generator by conducting suitable test.
CO 6	Examine the efficiency by performing Sumpner's test on two similar transformers.

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	2	-	-	-	-	3	2	-	3
CO 2	3	3	2	2	-	-	-	-	3	2	-	3
CO 3	3	3	2	2	-	-	-	-	3	2	-	3
CO 4	3	3	2	2	-	-	-	-	3	2	-	3
CO 5	3	3	2	2	-	-	-	-	3	2	-	3
CO 6	3	3	2	2	-	-	-	-	3	2	-	3

Assessment Pattern

Marks 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 equipment and troubleshooting)	25 Marks
(d) Viva voce	20 marks
(e) Record	5 Marks

General instructions: Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that 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 University examination only on submitting the duly certified Laboratory Record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1) Conduct a brake test on the given DC series motor and plot its electrical characteristics and speed versus armature current curve.
2) Plot the load characteristics of the given differentially compounded DC generator by conducting suitable experiments.
3) Plot the electrical and mechanical characteristics of the given DC shunt motor by conducting suitable experiments.

Course Outcome 2 (CO2):

1) Predetermine the OCC of the given D.C shunt generator when running at 80% rated speed and also find the critical resistance at rated speed.
2) Plot the OCC of the D.C shunt generator at its rated speed and obtain its critical resistance and critical speed. Also obtain the additional resistance required in the field circuit for generating rated voltage on no load.

Course Outcome 3(CO3):

1) Predetermine the per phase equivalent circuit of the 3 phase transformer referred to low voltage side by conduction suitable experiments. Also compute its KVA corresponding to maximum efficiency.
2) Predetermine the maximum efficiency of the given single phase transformer at upf by conducting suitable experiment. Also compute its full load regulation at upf.

Course Outcome 4 (CO4):

1) Plot the regulation and efficiency curves of the given 1-phase transformer by conducting a suitable experiment.
2) Plot the regulation and efficiency curves of the given 3-phase transformer by conducting a suitable experiment.

Course Outcome 5 (CO5):

1) Conduct a suitable test on the given DC shunt machine and predetermine the efficiency curve of the machine both as motor and as generator

Course Outcome 6 (CO6):

1) Conduct a suitable test on two similar 1-phase transformers and predetermine its efficiency at full load and 0.8 pf lagging.
2) Conduct a suitable test on two similar 1-phase transformers and predetermine its efficiency at half load and UPF.

LIST OF EXPERIMENTS

PART A- DC MACHINES

1. **Open Circuit Characteristics of a DC Shunt Generator**

   Objectives:

   a) Predetermine the OCC at different speeds
   b) Determine the critical field resistance
   c) Obtain maximum voltage built up with given shunt field
   d) Obtain critical speed for a given shunt field resistance

2. **Load Test on a DC Shunt Generator**

   Objectives:

   a) Determine the external & internal characteristics of the given DC Shunt Generator

3. **Brake Test on a DC Shunt Motor**

   Objectives:

   Plot the following characteristics
   a) Performance characteristics
   b) Electrical characteristics
   c) Mechanical characteristics.

4. **Brake Test on a DC Series Motor**

   Objectives:

   Plot the following characteristics
   a) Performance characteristics
   b) Electrical characteristics
   c) Mechanical characteristics.

5. **Load Characteristics of a DC Compound Generator**

   Objectives:

   a) To plot the load characteristics of the given DC Compound generator when cumulatively compounded.
   b) To plot the load characteristics of the given DC Compound generator when differentially compounded

6. Swinburne's Test on a DC Shunt Machine

Objectives:

a) To predetermine the efficiency of a D.C. shunt machine when the machine operates as a motor and as a generator for various load conditions
b) To plot the efficiency curves of the given DC machine.

7. Hopkinson's test on a pair of DC machines

Objectives:

Determination of the efficiency of the given dc shunt machine working as a motor and generator under various load conditions.

8. Retardation test on a DC machine

Objectives:

a) Separation of hysteresis, eddy current, friction &windage losses
b) Find the moment of inertia of the rotating system

9. Separation of losses in a DC shunt motor

Objectives:

a) Separation of hysteresis, eddy current, friction &windage losses
b) Plot the losses vs speed curves

PART B - TRANSFORMERS

10. OC & SC Tests on a Single Phase Transformer

Objectives:

a) To pre-determine the regulation and efficiency of the given single phase transformer at different loads and power factors
b) To obtain the equivalent circuit of the given transformer
c) To plot regulation vs power factor curves
d) To determine the power factors at which regulation is zero

11. DirectLoad Test on a Single Phase Transformer

Objectives:

a) To determine the efficiency of the given transformer at unity power factor at different loads
b) To determine the regulation of the given transformer at unity power factor at different loads
c) To plot the efficiency vs output and regulation vs output curves

12. Separation of Constant losses of a Single Phase Transformer

Objectives:

a) To separate hysteresis and eddy current losses of a single phase transformer, keeping V/f constant.
b) To plot losses vs. frequency curves, by separating the hysteresis and eddy current losses at normal voltage and different frequencies.

13. Sumpner's Test

Objectives:

a) To predetermine efficiency at different loads and power factors
b) To predetermine regulation at different loads and power factors
c) To determine the equivalent circuit

14. Parallel Operation of two dissimilar Single Phase Transformers

Objectives:

a) To determine the load sharing of each transformer by their equivalent impedances.
b) To verify the load sharing by actual measurement.

15. OC & SC Tests on a Three Phase Transformer

Objectives:

a) To predetermine the efficiency at different load conditions and power factors.
b) To predetermine the regulation at different power factors.
c) To develop the per phase equivalent circuit.

Reference Books

1. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
2. Theraja B. L., A Textbook of Electrical Technology, S. Chand & Company, New Delhi,

CODE EEL204	DIGITAL ELECTRONICS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

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

CO 1	Formulate digital functionsusing Boolean Algebra and verify experimentally.
CO 2	Design and implement combinational logic circuits.
CO 3	Design and implement sequential logic circuits.
CO 4	Design and fabricate a digital circuit using the knowledge acquired from the laboratory.

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	1	1	3	3			2	3	3		1
CO 2	3	3	3	3	3			2	3	3		1
CO 3	3	3	3	3	3			2	3	3		1
CO 4	3	2	1	3	2			2	3	3	2	3

LIST OF EXPERIMENTS

Pre-lab assignment :Familiarisation of Logic Gates, Identification of typical logic ICs, Interpreting IC datasheets.

1. Verification & Realisation of De Morgan's theorem.
2. Realisation of SOP & POS functions after K-map reduction.
3. Half adder & Full adder using gates.
4. 4-bit adder/subtractor & BCD adder using IC 7483.
5. Realisation of 2-bit comparator using gates and study of four-bit comparator IC 7485.
6. BCD to decimal decoder and BCD to 7-segment decoder & display.
7. Study of multiplexer IC and realization of combinational circuits using multiplexers.
8. Realization of RS, T, D & JK flip flops using gates.
9. Study of flip flop ICs (7474 & 7476).
10. Realisation of ripple up and down counters and modulo-N counter using flip-flops.
11. Study of counter ICs (7490, 7493).
12. Design of synchronous up, down & modulo-N counters.
13. Realization of 4-bit serial IN serial OUT registers using flip flops.
14. Study of shift register IC 7495, ring counter and Johnsons counter.
15. VHDL implementation of full adder, 4 bit magnitude comparator

Course Project : Students have to do a mandatory course project (group size not more than 4 students) using digital ICs or Programmable Logic Devices (CPLD/FPGA) to realise a functional digital circuit. A maximum of 5 marks shall be awarded for this project (to be evaluated along with the final internal test).

Example of course projects :

1. Realisation of a real-time digital clock with display.
2. Digital Alarms
3. ALU (May be implemented in FPGA)
4. Digital Security Monitoring System
5. Traffic Control

Assessment Pattern :

Mark distribution :

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	Regular Lab work	InternalTest	CourseProject	Total
15	30	25	5	75

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 equipment and troubleshooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

General instructions : Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that 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 University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Reference Books:

1. Floyd T.L, Digital Fundamentals, 10/e, Pearson Education, 2011.
2. C.H.Roth and L.L.Kimney Fundamentals of Logic Design, 7/e, Cengage Learning, 2013.

SEMESTER -4

MINOR

Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET282	ELECTRICAL MACHINES	Minor	3	1	0	4

Preamble : This course gives exposure to the students about the concepts of electrical machines including constructional details, principle of operation and performance analysis.

Prerequisite : **Basics of Electrical Engineering**

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

CO 1	Identify the appropriate Electrical machines required for different applications, considering the parameters like input supply voltage, output torque and speed.
CO 2	Evaluate the performance of a single phase transformer based on appropriate test results.
CO 3	Analyse the performance of single phase and permanent magnet motors which can be used for household applications.

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	2										2
CO 2	2	3										2
CO 3	3	2										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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. Discuss the types of dc generators based on the method of excitation.(K2)
2. Discuss the applications of dc motors based on their characteristics.(K3)
3. Derive the expression for induced emf of alternator.(K1)
4. Problems on calculating induced emf of alternator. (K2, K3)
5. Why synchronous motor is not self starting? Discuss any two starting methods of synchronous motor? (K1)
6. What are V and Inverted V curves? (K1)
7. Explain the working principle of a three phase induction motor.(K1)
8. Why starting current of induction motor is high? Explain any two starting methods? (K2)

Course Outcome 2 (CO2):

1. Draw the phasor diagram of a single phase transformer. (K1)
2. Problems based on efficiency calculations, all day efficiency.(K2, K3)

Course Outcome 3 (CO3):

1. With the help of a neat diagram explain any two starting methods of single phase induction motor. (K1)
2. Discuss the advantages of permanent magnet rotor compared to the conventional construction. (K2)
3. Explain the principle of operation of a stepper motor.(K1)

Model Question paper

QP CODE:

PAGES:2

Reg. No:______________
Name:_______________

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

Course Code: EET 282
Course Name: Electrical Machines

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Derive an expression for emf generated in a dc machine.
2. Explain the principle of operation of a dc motor.
3. Draw the phasor diagram of a single phase transformer working under no load condition.
4. The emf per turn of a single phase 2200/220 V, 50 Hz transformer is approximately 12 V. Calculate (a) the primary and secondary turns (b) the net cross sectional area of the core if the maximum flux density is 1.5Wb/m^2.
5. How is voltage regulation of an alternator affected by the load connected to its terminals?
6. Why is synchronous motor not self starting?
7. Explain torque-slip characteristics of a three phase induction motor.
8. A three phase induction motor has 2 poles and is connected to 400 V, 50 Hz supply. Calculate the actual rotor speed and rotor frequency when slip is 4%.
9. Explain the working of a single phase induction motor.
10. List any three applications of PMBLDC motors.

(10 x 3 = 30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Briefly explain armature reaction of a dc machine. **(5)**
    (b) Classify dc generators based on their method of excitation with the help of neat diagrams. **(9)**
12. (a) Explain the power stages of a dc motor. **(4)**
    (b) A 75 kW, 250 V dc compound generator has the following data. R_a = 0.04Ω, R_{se}=0.004Ω, R_f = 100Ω, Brush contact drop = 1V/brush. Compare the generated emf when fully loaded for (i) short shunt compound (ii) long shunt compound. **(10)**

Module 2

13. (a) Draw the equivalent circuit of a single phase transformer and explain how the parameters are obtained from the test results. **(10)**
    (b) In a 25 kVA, 2000/200 V transformer, the iron and copper losses are 300 W and 400 W respectively. Calculate the efficiency at unity pf at (i) full load (ii) half load. **(4)**
14. (a) What is all day efficiency? Explain its significance. **(4)**
    (b) A transformer has its maximum efficiency of 0.98 at 20 kVA at unity pf. During the day it is loaded as follows: 12 hours - 2 kW at pf 0.6, 6 hours – 10 kW at pf 0.8, 6 hours – 20 kW at pf 0.9. Find the all day efficiency of the transformer. **(10)**

Module 3

15. (a) Explain the constructional details of a synchronous machine. **(9)**
    (b) A 200 kVA, 3.3 kV, 50 Hz, three phase synchronous generator is star connected. The effective armature resistance is 5Ω/phase and synchronous reactance is 29.2Ω/phase. At full load calculate the voltage regulation for 0.8 lagging and 0.8 leading power factors. **(5)**
16. (a) (i) Explain V curves of a synchronous motor. **(3)**
    (ii) What is a synchronous condenser? **(2)**
    (b) What is voltage regulation? Explain the method of finding regulation by emf method. **(9)**

Module 4

17. (a) Explain the working principle of a three phase induction motor. **(5)**
    (b)Explain the methods of starting of a three phase induction motor. **(9)**
18. (a) The no load and blocked rotor test results conducted on a 30 hp, 835 rpm, 440V, 3 phase, 60 Hz, squirrel cage induction motor are as follows.
    No load test: 440V, 14 A, 1470 W
    Blocked rotor test: 163V, 60A, 7200W
    Resistance measured between two terminals is 0.5Ω. Determine the equivalent circuit parameters. **(10)**
    (b) What is a self-excited induction generator? **(4)**

Module 5

19. (a) What are the applications of servomotors? **(4)**
    (b) Explain the different types of stepper motors. **(10)**
20. (a) What are universal motors? Explain their working. **(9)**
    (b) Write a short note on permanent magnet motors. **(5)**

(14 x 5 = 70)

Syllabus

Module 1

DC Machines-principle of operation of DC generator - emf equation - types of excitations - separately excited, shunt and series excited DC generators, compound generators. General idea of armature reaction, Open circuit and load characteristics-simple numerical problems. Principles of dc motors-torque and speed equations-torque speed characteristics-Characteristics and applications of dc shunt, series and compound motors. Methods of starting, losses and efficiency - simple numerical problems.

Module 2

Transformers –principle of operation –emf equation - phasor diagram - losses and efficiency –OC and SC tests. Equivalent circuits-efficiency calculations - maximum efficiency –all day efficiency –simple numerical problems.

Module 3

Synchronous machines–Parts of synchronous generator – principle of operation–types –emf equation of alternator – regulation of alternator under lagging and leading power factor – determination of regulation by emf method – numerical examples. Principle of operation of synchronous motors - methods of starting - V curves - synchronous condenser.

Module 4

Three phase induction motors-slip ring and squirrel cage types-principle of operation–rotating magnetic field–equivalent circuit, torque slip characteristics-no load and blocked rotor tests. Methods of starting –direct online, star delta, rotor resistance and auto transformer starting.

Induction generator- principle of operation – self excited induction generators.

Module 5

Single phase motors - principle of operation of single phase induction motor –split phase motor – capacitor start motor.

Stepper motor – principle of operation – types. Principle of operation and applications of universal motor and servomotor (dc and ac).

Permanent magnet motors– principle of operation of PMSM and PMBLDC motor, applications.

Text Books

1. Bimbra P.S., “Electrical Machinery”, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D.P. Kothari, “Theory of AC Machines”, Tata McGraw Hill, 2006.

Reference Books

1. Fitzgerald A.E., C. Kingsley and S. Umans, "Electric Machinery", 6/e, McGraw Hill, 2003.
2. Langsdorf M.N., "Theory of Alternating Current Machinery", Tata McGraw Hill, 2001.
3. Say M.G., "The performance and Design of AC Machines", CBS Publishers, New Delhi, 2002.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**DC Machines(10 hours)**	
1.1	Principle of operation-emf equation-types of excitations -separately excited, shunt and series excited DC generators, compound generators.	3
1.2	Generalidea of armature reaction, OCCand load characteristics-simple numerical problems.	2
1.3	Principles of dc motors-torque and speed equations-torque speed characteristics	2
1.4	Characteristics and applications of dc shunt, series and compound motors. Principles of starting, losses and efficiency–simple numerical problems.	3
2	**Transformers (8 hours)**	
2.1	Principle of operation –emf equation - phasor diagram.	2
2.2	losses and efficiency –OC and SC tests. Equivalent circuit.	3
2.3	efficiency calculations-maximum efficiency –all day efficiency –simple numerical problems.	3
3	**Synchronous machines (9 hours)**	
3.1	Parts of synchronous generator – principle of operation – types	2
3.2	emf equation of alternator –regulation of alternator under lagging and leading power factor – simple numerical problems.	2
3.3	determination of regulation by emf method – numerical examples.	2
3.4	Principle of operation of synchronous motors-methods of starting.V-curves-synchronous condenser.	3

4	**Three phase induction motors (9 Hours)**	
4.1	Slip ring and squirrel cage types-principle of operation–rotating magnetic field.	2
4.2	Torque-slip characteristics-no load and blocked rotor tests, equivalent circuit - simple numerical problems.	3
4.3	Methods of starting –direct online, star-delta, rotor resistance and autotransformer starting.	2
4.4	Induction generator- principle of operation – self excited induction generators.	1
5	**Single phase motors (9 Hours)**	
5.1	Principle of operation of single phase induction motor –split phase motor –capacitor start motor-	2
5.2	Stepper motor – principle of operation - types	2
5.3	Universal motor, –servomotor – dc and ac servomotors – principle of operation, applications.	3
5.4	Permanent magnet motors – principle of operation of PMSM and PMBLDC motor, applications.	2

Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET284	**Energy Systems**	**Minor**	**3**	**1**	**0**	**4**

Preamble : This course introduces various types of renewable energy sources. It discusses various means of generating and storing energy and the importance of renewable energy. Various energy standards and means to improve efficiency of systems are also introduced

Prerequisites : EST 130Basics of Electrical & Electronics Engineering

EET 253 Introduction to Power Engineering

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

CO 1	Illustrate Indian and global energy scenario
CO 2	Elaborate different conventional and non-conventional energy generation schemes and the economics of generation
CO 3	Analyse principle of operation and performance comparison of various energy storage schemes
CO 4	Identify major Global and Indian standards for Energy Management
CO 5	Perform a preliminary Energy Audit
CO 6	Appraise various aspects of energy economics

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
CO 4	3	3										2
CO 5	3	3										2
CO 6	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	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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 (CO 1):

1. Discuss Indian and world energy scenario (K1)
2. Describe Indian energy sector reforms (K2)
3. Discuss energy and environment, energy security (K2)
4. Explain the features of Energy Conservation Act (K3)

Course Outcome 2 (CO 2):

1. Describe various sources of non conventional energy (K2)
2. Problems on calculating efficiency of Solar Photovoltaic Systems (K3)
3. Problems on energy availability from wind(K3)
4. Discuss the generation of energy from wave, tide, OTEC and Biomass (K2)

Course Outcome 3 (CO 3):

1. Describe various means of energy storage (K2,)
2. Explain the working of batteries (K2)
3. Calculate the efficiency of fuel cells (K3).

Course Outcome 4 (CO 4):

1. Identify ISO 50001 for Energy Management. (K2)
2. Describe the activities of BEE in India and star rating of equipment (K2).

Course Outcome 5 (CO 5):

1. Give the steps involved in Energy Audit (K1)
2. Calculate the payback period (K3).

Course Outcome 6 (CO 6):

1. Classify different types of tariff (K3)
2. Compare models for demand forecasting (K3)
3. Explain how economic analysis of energy investment is done (K2)

Model Question paper

QPCODE: PAGES: 2

Reg.No:____________

Name:______________

APJABDULKALAMTECHNOLOGICALUNIVERSITY

FOURTH SEMESTERB.TECHDEGREEEXAMINATION, MONTH &YEAR

Course Code: EET 284

Course Name: Energy Systems

Max.Marks:100 **Duration: 3Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Enumerate the important features of Energy Conservation act.
2. Illustrate the concept of green buildings.
3. Find the maximum power and efficiency of a 100 x 100 mm sq. solar cell having an open circuit voltage is 0.611 V, Short circuit current of 3.5 A, Fill factor of 0.7 when input power is 10 W.
4. Draw and explain the block diagram of the ocean thermal energy system.
5. Derive the expression for the power output and efficiency of a fuel cell.
6. Give the relative advantages and disadvantages of battery storage.
7. Discuss the structure of a detailed energy audit report.
8. What is the significance of the energy audit?
9. What is the difference between long term and short forecasting? What is MAED?
10. Differentiate between cost of capital and discount rate.

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Compare Energy Scenario of India and the world. **(10)**

(b) The luminous efficiency of a lamp is 8.8 Lumens/Watt and its luminous intensity is 700 Cd. What is the power of the lamp? **(4)**

12. (a) Compare any four types of lamps. Give their approximate efficiencies as well. **(8)**
    (b) Discuss the energy system reforms in India and illustrate their effect. **(6)**

Module 2

13. (a) Explain how energy can be extracted from the heat and light of sun. **(10)**
    (b) Determine the power in the wind if the wind speed is 20 m/s and blade length is 50 m and air density = 1.23 kg/m^3. **(4)**

14. (a) Compare the schemes for extraction of energy from waves and tides. **(8)**
    (b) Explain with the help of a schematic, extraction of energy from biomass. **(6)**

Module 3

15. (a) Differentiate between primary and secondary cells. **(4)**
    (b) Explain the working of any one primary and secondary cell with the help of diagrams **(10)**

16. (a) Give the importance of energy storage. **(4)**
    (b)Compare compressed air and fly wheel energy storage systems. **(10)**

Module 4

17. (a) Explain the important features of ISO 50001. **(6)**
    (b) Discuss are the functions of Bureau of Energy efficiency. What is the significance of star ratings? **(8)**

18. (a) Explain the types of energy audit and their procedure. **(9)**
    (b) Explain various instruments used for energy audit. **(5)**

Module 5

19. (a) Explain LEAP energy planning system with the help of block diagram. **(6)**
    (b) A company is planning to install an energy-efficient motor requiring an initial investment of Rs 10.5 lakh. The motor is expected to save 2.5 lakh per year in net cash flows for 7 years. Calculate the payback period. **(8)**

20. (a) Explain one part, two part and three part tariff. **(9)**
    (b) A machine can reduce annual cost by Rs 40,000. The cost of the machine is Rs 223,000 and the useful life is 15 years with zero residual value. Calculate the Internal Rate of Return. **(5)**

(14x5=70)

Syllabus

Module 1

Energy Scenario: Indian Energy Scenario, World Energy Scenario, Indian Energy Sector Reforms, Energy and Environment, Energy Security, Energy conservation act

Energy Efficient Systems: Reducing pollution and improving efficiency in buildings, Green Building Standards, Types of lamps and their efficiencies

Module 2

Renewable Energy Resources: Solar Thermal System-Working Principle-Block diagram, Solar Photovoltaic System- Working Principle-Block diagram, Solar cell efficiency calculation, Wind Energy Systems- Working Principle-Block diagram, wind power equation, Energy from Waves and tides- Working Principle-Block diagram, Ocean Thermal Energy System- Working Principle-Block diagram, Energy from Biomass

Module 3

Energy Storage: Importance of Energy Storage- Means of Storing Energy- Principle of operation and performance comparison. Compressed air storage, Fly wheel Energy Storage, Battery Storage-**Battery:** Specification, Charging/Discharging rate, Primary and secondary cells-Dry cell, lead acid, lithium ion, Lithium air, Nickel Cadmium, Nickel Metal Hydride

Fuel Cell: Working Principle, efficiency

Module 4

Energy Standards – International Energy Standards-ISO50001, Bureau of Energy Efficiency, star rating

Energy Management: Significance and general principles of Energy Management, Energy audit-types and procedure, Energy audit report, Instruments for energy auditing

Study of various governmental agencies related to energy conservation and management.

Module 5

Energy Economics: Traditional Types of Rates - Single-Part Rates - Two-Part Rates - Three-Part Rates – Numerical problems

Energy demand forecasting: Introduction –Forecasting using simple indicators- trend analysis- end use method - MAED Model - LEAP Model

Economic Analysis of Energy Investments - calculation of energy efficiency and payback period - Characteristics of Energy Projects - Identification of Costs and Benefits - Valuation of Costs and Benefits - Indicators of Cost-Benefit Comparison:Methods Without Time Value - Net Present Value Based Indicators - Role of Discount Rates - Internal Rate of Return – Numerical Problems

Text Books

1. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011.
2. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy Management", Seventh Edition, The Fairmont Press Inc., 2012.
3. S. Pabla, "Electric Power Systems Planning", Mac Millan India Ltd., 1998

References:

1. K.C. Kothari, D.P.Ranjan, Rakeshsingal "Renewable Energy Sources and Emerging Technology"- PHI; 2nd Revised edition (1 December 2011)
2. M.V.R. Koteswara Rao, Energy Resources: Conventional & Non-Conventional BS Publications/BSP Books (2017)
3. Albert Thumann, Scott Dunning, "EFFICIENT LIGHTING APPLICATIONS & CASE STUDIES"; The Fairmont Press, Inc. (16 April 2013)
4. "Energy Efficiency in Electrical Utilities"-Guide book for National Certificate Examination for Energy Managers and Energy Auditors : Bureau of Energy Efficiency
5. Subhes C. Bhattacharyya, "Energy Economics-Concepts, Issues, Markets and Governance," Springer, 2011
6. ISO50001

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Energy Scenario (9hours)**	
1.1	Indian and world Energy Scenario	2
1.2	Indian Energy Sector reforms	1
1.3	Energy, Environment, Energy Security	1
1.4	Green Building Standards, Industries and electrical Power System	2
1.5	Energy Conservation Act 2001 features	1
1.6	Green Building Standards	1
1.7	Types of lamps and their efficiencies	1
2	**Non-Conventional Energy Sources. (9hours)**	
2.1	Solar Thermal System, Working Principle- Solar cell efficiency Calculation	2
2.2	Solar Photovoltaic System-Working Principle	1
2.3	Wind Energy Systems-Working Principle	2

2.4	Energy From waves and Tides-Block diagram	2
2.5	Energy from Biomass and Ocean Thermal Energy Systems	2
3	**Energy Storage (9 Hours)**	
3.1	Specification, Discharging time calculation	1
3.2	Compressed air storage, Fly wheel Energy Storage, Battery Storage-Advantages	2
3.3	Primary and secondary cells-Dry cell	1
3.4	lead acid, lithium ion, Lithium air, Nickel Cadmium, Nickel Metal Hydride	3
3.5	Fuel Cells, Working Principle, efficiency calculation	2
4	**Energy Management (9 Hours)**	
4.1	International Energy Standards-ISO50001	2
4.2	Bureau of Energy Efficiency, star rating	2
4.3	Significance and general principles of Energy Management, Energy audit-types, procedure, instruments and reports	4
4.4	Study of various governmental agencies related to energy conservation and management.	1
5	**Energy Economics (9 Hours)**	
5.1	Traditional Types of Rates - Single-Part Rates - Two-Part Rates - Three-Part Rates – Numerical problems	3
5.2	Energy demand forecasting: Introduction –Forecasting using simple indicators- trend analysis- end use method - MAED Model - LEAP Model	2
5.3	Economic Analysis of Energy Investments - Characteristics of Energy Projects - Identification of Costs and Benefits - Valuation of Costs and Benefits - Indicators of Cost-Benefit Comparison:Methods Without Time Value - Net Present Value Based Indicators - Role of Discount Rates	3
5.4	Internal Rate of Return – Numerical Problems	1

EET286	PRINCIPLES OF INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		MINOR	3	1	0	4

Preamble: This course introduces principle of operation and construction of basic instrumentation components, their selection and applications.Familiarization of modern basic digital systems are also included.

Prerequisite: Basics of Electronics and Circuits

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

CO 1	Identify and analysethe factors affecting performance of instrumentation system
CO 2	Choose appropriate instrumentation system components for the measurement of different parameters
CO 3	Identify different amplifier circuits for instrumentation including selection of Op-amp for linear and Non-linear applications.
CO 4	Identification and selection of basic filters for instrumentation
CO 5	Outline the principles of operation of linear &Non-linear signal processing systems
CO 6	Understand the operating principles of basic building blocks of digital systems, recording and display units

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	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	1	-	-	-	-	-	-	2
CO 6	3	-	-	-	2	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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. What is the loss angle of a capacitor?
2. Explain sensitivity.
3. What is the theoretical relationship between the current through a pn-diode and the voltage across it?

Course Outcome 2 (CO2):

1. What phenomenon is described by the early effect?
2. What is the loss angle of a capacitor?
3. What types of transducers are used for pressure measurements?

Course Outcome 3(CO3):

1. How to design a second order band pass filter using an OPAMP circuit?
2. Explain the working of Schmitt trigger using OPAMP circuit?
3. Show how Analog multipliers can be used for division and square rooting applications?

Course Outcome 4 (CO4):

1. Explain the different types of passive filters.
2. Differentiate between first and second order filters.

Course Outcome 5 (CO5):

1. What is an amplitude modulated signal with a suppressed carrier?
2. Explain phase locked loop (PLL).
3. How to calculate the maximum digital output error for 3-bit cascaded converter?
4. Explain why the pulse frequency is not of importance to the dual slope converter

Course Outcome 6 (CO6):

1. Block diagram of DMM, CRO, DSO
2. Explain the handshake procedure and indicate also what implications this has for data transmission speed?
3. Discuss the main aspects of “virtual instruments”.

MODEL QUESTION PAPER

QP CODE: PAGES:3

Reg No:______________

Name :______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR Course Code: EET 286

Course Name: **PRINCIPLES OF INSTRUMENTATION**

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carries 3 Marks

1. What is transducer?
2. What you mean by DC hall effect sensors?
3. How we can find the maximum operating signal frequency of OPAMP?
4. Determine the output voltage of an op-amp for input voltages of V_{i1} = 150 µV, V_{i2} = 140 µV. If it has a differential gain of A_d = 4000 and the value of CMRR is 100
5. Explain voltage-controlled oscillator?
6. What is meant by multiplexing?
7. Draw the block diagram of Dual slope ADC.
8. Calculate the cut-off frequency of a first-order low-pass filter for R_1 =1.2 kΩ and C_1 =0.02 µF.
9. Explain Synchronization and triggering operation in CRO
10. What is use of spectrum and network analysers?

(10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a)To obtain the value of the series resistance $\mathbf{r_s}$ of a diode the voltage is measuredin two different currents: 0.1 mA and 10 mA. The respective results are 600 mVand 735 mV. Find $\mathbf{r_s}$. **(4)**

    b)With neat diagram explain the working of diode peak detector. **(5)**

    c)Give the approximate value of the differential resistance of a pn-diode at 1 mA,at 0.5 mA and at 1 µA. Give also the conductance values. **(5)**

12. a)Explain with neat diagram explain the operation of diode Limiter/clipper. **(7)**

    b) Explain about thermocouples and their practicaluse in instrumentation. **(7)**

Module 2

13. a)What phenomenon is described by the early effect? **(4)**
 b.Explain the working of differential amplifier. **(5)**
 c. State and explain Inverse square law and Lamberts cosine law. **(5)**
14. a) If the input signal has an rms value of 1 V, the op amp input impedance is 1 MΩ and the circuit's load resistance is 1 kΩ. What is the load current? Express the power gain in terms of the input resistance R_i and the load resistance R_L, what is its value in decibels? **(8)**
 b) Derive the expression for noise factor in OPAMP amplifiers **(6)**

Module 3

15. a)Explain the operation of Active voltage limiter and its advantages over diode voltage limiters. **(6)**

 b) With neat diagram explain the operation of Schmitt trigger. Why positive feedback is provided always in the comparator circuit using an OPAMP? Also explain the hysteresis property of Schmitt trigger circuit. **(8)**

16. a)A voltage amplifier is specified as follows: input offset voltage at 20°C is < 0.5 mV, the temperature coefficient of the offset is < 5 μV/K. Calculate the maximum input offset that might occur within a temperature range of 0 to 80 °C. **(6)**

 b) In the integrator circuit given below the component values are C = 1 mF and R = 10 kW. The specifications of the operational amplifier are: $|V_{off}|$ <0.1 mV and $|I_{bias}|$ < 10 nA. The input is supposed to be zero. At t = 0 the output voltage v_o = 0. What is the value of v_o after 10 seconds? **(8)**

Module 4

17. a) Explain why the pulse frequency is not of importance to the dual slope converter. **(4)**

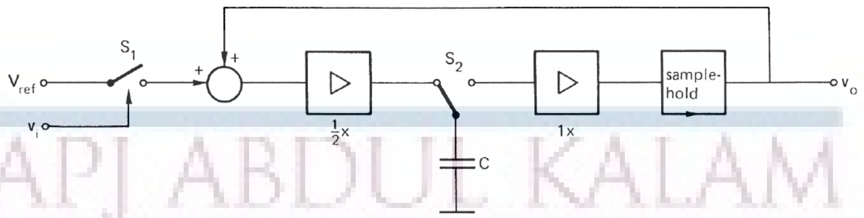
 b) The integration period of an integrating AD-converter is 100 ms ±1 μs.Determine the maximum conversion error caused by a 50 Hz interferencesignal withrms value of 1 V. **(6)**
 c)Explain R-2R ladder digital to analog converter operation. **(4)**

18. a)What is the differential non-linearity of a DA-converter? What is monotony? **(4)**

 b) The clock frequency of a 10-bit successive approximation AD-converter is 200 kHz. Find the (approximated) conversion time for this converter. **(6)**
 c) Explain the term "multiplying DAC" for a DA-converter with external reference. **(4)**

Module 5

19. a) The input signal of the DAC in Figure below is the 3-bit word 101. Make a plot of the relevant output signal versus time. The capacitor is uncharged for t < 0.**(10)**



b)The reference voltage of a 10-bit DA-converter is 10 V. Calculate the outputvoltage when the input code is 1111100000 (MSB first). **(4)**

20. a) Explain the operation of Integrating AD-converters with neat diagram. **(6)**

b)Explain the operation of parallel AD-converters with neat diagram. **(8)**

Syllabus

Module 1

Passive electronic components– Resistors- Capacitors- Inductors and transformers

Circuits with pn-diodes - Limiters - Peak detectors - Clamp circuits - DC voltages sources

Sensors– Sensor components - Resistive sensors - Inductive sensors - Capacitive sensors - Thermoelectric sensors - Piezoelectric sensors.

Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.

Module 2

Circuits with bipolar transistors & field effect transistors - Voltage-to-current converter - voltage amplifier stage with base-current bias - voltage amplifier stage with a base-voltage bias - emitter follower - source follower- differential amplifier

Operational amplifiers - Amplifier circuits with ideal operational amplifiers - Current-to-voltage converters - Inverting voltage amplifiers - Non-inverting voltage amplifiers - Differential amplifiers -Instrumentation amplifiers

Non-ideal operational amplifiers - Selection of operational amplifiers (Specifications)- Input offset voltage - Finite voltage gain

Module 3

Nonlinear signal processing with OPAMP - Voltage comparators - Schmitt-trigger - Voltage limiters - Rectifiers - Nonlinear arithmetic operations - Logarithmic converters - Exponential converters – Multipliers and other arithmetic operators

Electronic switching circuits - Electronic switches - Properties and Components as electronic switches - Circuits with electronic switches - Time multiplexers - Sample-hold circuits - Transient errors

Passive filters - First and second order RC-filters - Low-pass first-order RC-filter – High pass first-order RC-filter - Bandpass filters - Notch filters

Module 4

Modulation and Demodulation - Amplitude modulation and demodulation - Amplitude modulation methods - Demodulation methods. Systems based on synchronous detection - Phase-locked loop - Lock-in amplifiers - Chopper amplifiers

Digital-to-Analogue and Analogue-to-Digital conversion - Parallel converters - Binary signals and codes - Parallel DA-converters - Parallel AD-converters. Special converters - The serial DA-converter - The direct AD converter - Integrating AD-converters

Module 5

Measurement instruments - Stand-alone measurement instruments - Multimeters - Signal generators - Counters, frequency meters and time meters - Spectrum analyzers - Network analyzers - Impedance analyzers

Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.

Computer-based measurement instruments - Bus structures - Introduction to Virtual Instrumentation systems- Simulation softwares(description only)

Text Books

1. D. Patranabis, ‘Sensors and Transducers’, Prentice Hall of India, 2003
2. Helfrick& Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India,5th Edition,2002
3. Sawhney A.K., A course in Electrical and Electronic Measurements & instrumentation, DhanpatRai.
4. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012
5. S Tumanski, Principles of electrical measurement, Taylor & Francis.
6. David A Bell, Electronic Instrumentation and Measurements,3/e, Oxford

Reference Books

1. Cooper W.D., Modern Electronics Instrumentation, Prentice Hall of India
2. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill
3. E.O Doebelin and D.N Manik, Doebelin’s Measurements Systems, sixth edition, McGraw Hill Education (India) Pvt. Ltd.
4. P.Purkait, B.Biswas, S.Das and C. Koley, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education (India) Pvt. Ltd.,2013

Course Contents and Lecture Schedule

Module	Topic coverage	No. of Lectures
1	**Basic Instrumentation Circuit Components (9 hours)**	
1.1	Passive electronic components– Resistors- Capacitors- Inductors and transformers. Circuits with pn-diodes - Limiters - Peak detectors - Clamp circuits - DC voltages sources	3
1.2	Sensors– Sensor components - Resistive sensors - Inductive sensors - Capacitive sensors - Thermoelectric sensors - Piezoelectric sensors	3
1.3	Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge.	3
2	**Transistor and amplifier circuits (9 hours)**	
2.1	Circuits with bipolar transistors - Voltage-to-current converter - voltage amplifier stage with base-current bias - voltage amplifier stage with a base-voltage bias - emitter follower - - differential amplifier.	2
2.2	Circuits with field-effect transistors - Voltage-to-current converter - voltage amplifier stage - source follower.	2
2.3	Operational amplifiers - Amplifier circuits with ideal operational amplifiers - Current-to-voltage converters - Inverting voltage amplifiers - Non-inverting voltage amplifiers - Differential amplifiers -Instrumentation amplifiers	3
2.4	Non-ideal operational amplifiers - Selection of operational amplifiers (Specifications)- Input offset voltage - Finite voltage gain	2
3	**Nonlinear signal processing with OPAMP and Filters (9 hours)**	
3.1	Nonlinear transfer functions - Voltage comparators - Schmitt-trigger - Voltage limiters - Rectifiers - Nonlinear arithmetic operations - Logarithmic converters - Exponential converters – Multipliers and other arithmetic operators	3

3.2	Electronic switching circuits - Electronic switches - Properties and Components as electronic switches - Circuits with electronic switches - Time multiplexers - Sample-hold circuits - Transient errors.	3
3.3	Passive filters - First and second order RC-filters - Low-pass first-order RC-filter – High pass first-order RC-filter - Bandpass filters - Notch filters	3
4	**Magnetic ,Lumen and Temperature Measurements (9 hours)**	
4.1	Modulation - Amplitude modulation and demodulation - Amplitude modulation Demodulation- Demodulation methods. Systems based on synchronous detection - The phase-locked loop - Lock-in amplifiers - Chopper amplifiers	4
4.2	Digital-to-Analogue and Analogue-to-Digital conversion - Parallel converters - Binary signals and codes - Parallel DA-converters - Parallel AD-converters	3
4.3	Special converters - The serial DA-converter - The direct AD converter - Integrating AD-converters	2
5	**Measuring instruments including modern recording and displaying instruments (9 hours)**	
5.1	Measurement instruments - Stand-alone measurement instruments - Multimeters - Signal generators - Counters, frequency meters and time meters - Spectrum analyzers - Network analyzers - Impedance analyzers.	4
5.2	Oscilloscopes- Principal of operation of general purpose CRO-basics of vertical and horizontal deflection system, sweep generator etc. DSO-Characteristics-Probes and Probing techniques.	3
5.3	Computer-based measurement instruments - Bus structures - Introduction to Virtual Instrumentation systems- Simulation software's (description only)	2

SEMESTER -4
HONOURS

Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET292	**NETWORK ANALYSIS AND SYNTHESIS**	**Core (Honors)**	**3**	**1**	**0**	**4**

Preamble : This honors course is designed with the objective of expanding the student's knowledge in network analysis beyond the basic topics. It includes advanced topics in network analysis, basics of filter design and network synthesis concepts. This course would help students to explore more advanced concepts in the analysis of complex networks.

Prerequisite : **EET201 Circuits and Networks**

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

CO 1	Apply network topology concepts in the formulation and solution of electric network problems.
CO 2	Apply two-port network analysis in the design and analysis of filter and attenuator networks.
CO 3	Identify the properties and characteristics of network functions, and verify the mathematical constraints for their physical realisation.
CO 4	Synthesize passive one-port networks using standard Foster and Cauer forms.

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
CO 4	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	15	15	20
Understand (K2)	20	20	50
Apply (K3)	15	15	30
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

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.

Model Question Paper

Reg. No.:
Name: **Pages: 4**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FOURTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR
Course Code: **EET292**

Course Name: Network Analysis and Synthesis

Max. Marks: 100 Time: 3 hrs

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

1. Define subgraph, path and a tree, with proper examples.
2. Describe the properties of the complete incidence matrix.
3. What are dual graphs? What is the condition for a network graph to have a dual? Illustrate with an example.
4. Describe a cut-set with an example.
5. Show that the image impedances of a two-port network are given by $Z_{im1} = \sqrt{\dfrac{AB}{CD}}$ and $Z_{im2} = \sqrt{\dfrac{BD}{AC}}$.
6. Draw the frequency response curves for ideal and non-ideal low pass filter, band pass filter, band reject filter, and high pass filter respectively.
7. For the pole-zero plot shown in Fig. 1 below, for a network function, identify the function and find its impulse response.
8. List the properties of positive real functions.
9. What are the properties of LC immittance functions.
10. Draw the Foster and Cauer forms of RC networks. (10 x 3 = 30)

Part B
Answer any one full question from each module.
Each question carries 14 Marks.
Module 1

11. (a) Draw the oriented graph of the given network shown in Fig. 2, and identify one tree and its co-tree. Obtain the incidence matrix. (6)

(b) Find all voltages and branch currents in the network shown in Fig. 3 by node analysis, and applying network graph principles. (8)

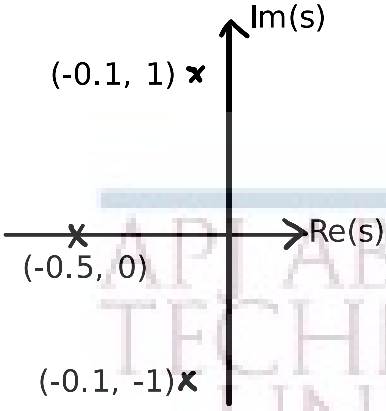


Figure 1: Pole Zero Plot

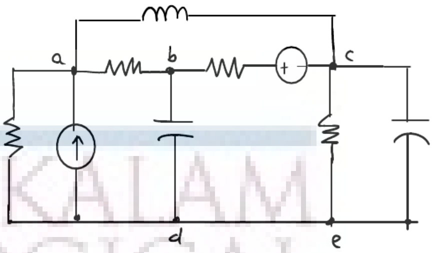


Figure 2: Figure for question 11 (a).

12. (a) The reduced incidence matrix A of an oriented graph is given below. (6)

$$A = \begin{bmatrix} -1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & -1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & -1 & 1 & 0 & -1 \\ 1 & 0 & 1 & 0 & 0 & 0 & -1 & 0 \end{bmatrix}$$

Draw the graph of an electrical network represented by this matrix. The branches constituting the outer loop of are independent current sources branches. All the current sources have their branch current variable at 1 A. Find the currents in all other branches.

(b) Find the total power dissipated in the circuit shown in Fig. 4 by node analysis (graph based). (8)

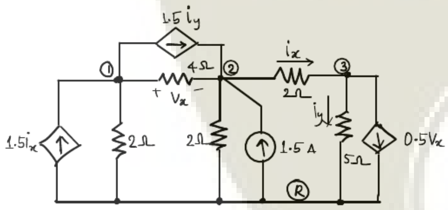


Figure 3: Figure for question 11 (b).

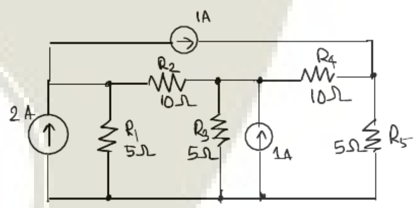


Figure 4: Figure for question 12 (b).

Module 2

13. (a) Find the power delivered by the independent voltage sources in the network shown in Fig. 5 by loop analysis (use graph theory). Prepare the network graph using the reference directions marked in the figure. (8)

(b) A connected network has the fundamental circuit matrix given as, (6)

$$B_f = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 \\ 1 & -1 & -1 & 0 & 0 & 1 \end{bmatrix}$$

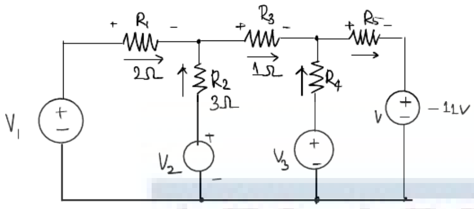


Figure 5: Figure for question 13 (a).

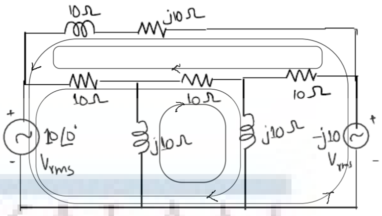


Figure 6: Figure for question 14 (a).

for some choice of tree. Obtain the f-cut-set matrix for the same tree.

14. (a) For the network shown in Fig. 6assign reference directions and draw the network graph. Obtain the connection matrix between branch currents and the loop currents in the three loops shown in the network diagram. Determine the loop impedance matrix of the network. (8)

(b) For the graph shown in Fig. 7, write the cut-set (KCL) equations for the following cut-sets: {1, 6}, {1,2,7,8}, {5, 6, 8, 9} and {2, 5, 7, 9}. Will this set of equations form an independent set of equations? If not why? (6)

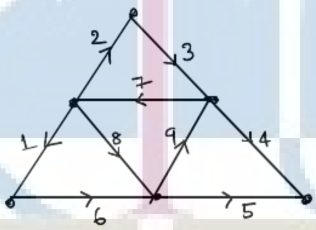


Figure 7: Figure for question 14 (b).

Module 3

15. (a) Design a prototype T-section low-pass filter to cut-off at 100 Hz with a load resistance of 75Ω. Calculate the attenuation in Np and in dB at 200 Hz and 1 kHz. Also find the phase shift suffered by the output signal for 10 Hz and 50 Hz. (7)

(b) Design an m-derived high pass filter having a design impedance of 300 Ω, cut-off frequency of 2000 Hz and infinite attenuation at 1700 Hz. (7)

16. (a) The open-circuit voltage observed across a signal source varies between ±100 mV. The voltage across a 60Ω resistance connected across this source is found to vary between ±50 mV. Design a T-section attenuator such that the voltage across a 600 Ω load connected across the output of the attenuator varies between ±5 mV. (7)

(b) Design the T-section and p-section of a constant K-type BPF that has a pass band from 1500 to 5500 Hz and characteristic resistance of 200 Ω. Further, find resonant frequency of series and shunt arms. (7)

Module 4

17. (a) Test the following polynomials for the Hurwitz property: (6)
   (i). $s^3 + s^2 + 2s + 2$
   (ii). $s^7 + s^5 + s^3 + s$
   (iii). $s^7 + 2s^6 + 2s^5 + s^4 + 4s^3 + 8s^2 + 8s + 4$

   (b) Determine whether the following functions are positive real or not: (8)
   (i). $F(s) = \dfrac{2s^2 + 2s + 4}{(s+1)(s^2+2)}$
   (ii). $F(s) = \dfrac{5s^2 + s}{s^2 + 1}$

18. (a) Find the limits of K so that the polynomial $s^3 + 14s^2 + 56s + K$ may be Hurwitz. (6)

   (b) Find the driving point impedance Z(s) in the form $K\dfrac{N(s)}{D(s)}$ for the network shown in Fig. 8. Verify that Z(s) is positive real and that the polynomial D(s)+KN(s) is Hurwitz. (8)

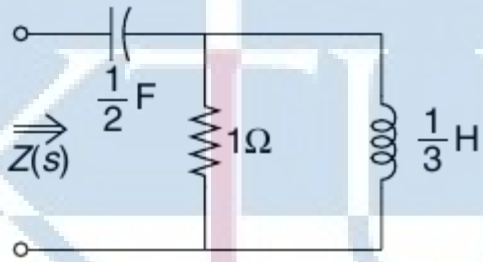


Figure 8: Figure for question 18 (b).

Module 5

19. Realise the impedance $Z(s) = \dfrac{2(s^2+1)(s^2+0)}{s(s^2+4)}$ in three different ways. (14)

20. (a) For the network function $Y(s) = \dfrac{2(s+1)(s+3)}{(s+2)(s+4)}$, synthesise a Foster form and a Cauer form realisations. (10)

   (b) Check whether the driving point impedance $Z(s) = \dfrac{s^4 + s^2 + 1}{s^3 + 2s^2 - 2s + 10}$ represents a passive network or not. (4)

Course Level Assessment Questions

Course Outcome 1 (CO1):

[K1]: Questions on Network topology terminology, definitions.

[K2}: Questions on identification of graphs, paths, sub-paths, etc., Questions on incidence matrix.

[K2, K3] Understand level and application level numerical problems on application of Kirchoff's laws in matrix formulation, nodal analysis.

[K2, K3]. Numerical problems on graph theory based network analysis, cut-set, circuit matrices, nodal and loop analysis.

Course Outcome 2 (CO2): [K1, K2] Questions on definitions and properties of filters.

[K2, K3]. Numerical problems on constant-k and m-derived filter design and analysis.

Course Outcome 3 (CO3): [K1] Questions on the properties of network functions and realizability of passive impedance functions.

[K2, K3]. Numerical problems on the realizability of network functions, testing of positive real functions and Hurwitz polynomials.

Course Outcome 4 (CO4): [K1]. Questions to describe Foster and Cauer forms and the properties of immittance functions.

[K2, K3]. Numerical problems to synthesise networks in Foster and Cauer forms.

Syllabus

Module 1

Network Topology (8 hours)

Linear Oriented Graphs -incidence matrix of a linear oriented graph –Kirchoff's Laws in incidence matrix formulation –nodal analysis of networks (independent and dependent sources) – Circuit matrix of linear oriented graph –Kirchoff's laws in fundamental circuit matrix formulation.

Module 2 (8 hours)

Loop analysis of electric networks (with independent and dependent sources) - Planar graphs –Mesh analysis- Duality –Cut set matrix -Fundamental cut set matrix –Relation between circuit, cut set and incidence matrices –Kirchoff's laws in fundamental cut-set formulation –Node-pair analysis – Analysis using generalized branch model (node, loop and node pair analysis) –Tellegen's theorem.

Module 3: (12 hours)

Modeling Two-port networks-application examples-amplifiers, transmission lines, passive filters.

Review of network parameter sets for two-port networks (z, y, h, g, T parameters, equivalent circuits and inter-relationship between parameters). (Review may be done using assignments/homeworks).

Image parameter description of a reciprocal two-port network -- Image impedance - Characteristic impedance - propagation constant—derivation of characteristic impedance and propagation constant for T and Pi networks under sinusoidal steady state -- Attenuation constant and phase constant.

Filter terminology: Low pass, high pass, band-pass and band-reject filters.

Constant k and m-derived filters -- low pass, high pass, band-pass and band-stop filters -- design--effect of cascading multiple sections. Resistive T, Pi and lattice attenuators.

Module 4

Network Functions (10 hours)

Review of Network functions for one port and two port networks: – pole zero location for driving point and transfer functions-Impulse response of Network functions from pole-zero plots- Sinusoidal steady-state frequency response from pole-zero plots.

Hurwitz polynomials –properties - Positive real functions –Properties of positive real functions – passivity-necessary and sufficient conditions for positive real functions-physical realizability.

Module 5

Synthesis of one port networks (8 hours)

Synthesis of reactive one-ports by Foster's and Cauer methods (forms I and II) -Synthesis of LC, RC and RL driving-point functions.

Text Books

1. K. S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2013

References

1. Franklin Kuo, "Network Analysis and Synthesis", 2nd Ed.,Wiley India.
2. Van Valkenburg M.E., "Introduction to Modern Network Synthesis," Wiley Eastern, 1960 (reprint 1986).
3. Van Valkenburg M.E, "Network Analysis," Prentice Hall India, 2014.
4. Charles A. Desoer and Ernest S. Kuh, "Basic Circuit Theory," Tata McGraw Hill Edition.
5. Chakrabarti, A., "Circuit Theory Analysis and Synthesis", DhanpatRai& Co., Seventh - Revised edition, 2018
6. S. K. Bhattacharya, "Network Analysis and Synthesis," Pearson Education India.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Network Topology (8 hours)**	
1.1	Linear Oriented Graphs - Connected Graph, sub graphs, paths, The incidence matrix of a linear oriented graph – Path matrix, its relation to incidence matrix.	2
1.2	Kirchoff's Laws in incidence matrix formulation – nodal analysis of networks (independent and dependent sources) principle of v-shifting.	2
1.3	Circuit matrix of linear oriented graph – Fundamental Circuit matrix B_f. Relation between All incidence matrix and All Circuit matrix.	2
1.4	Kirchoff's laws in fundamental circuit matrix formulation -	2
2	**(8 hours)**	
2.1	Loop analysis of electric networks (with independent and dependent sources) -- Planar graphs –Mesh analysis- Duality.	2
2.2	Cut set matrix -Fundamental cut set matrix –Relation between circuit, cut set and incidence matrices – Orthogonality relation.	2
2.3	Kirchoff's laws in fundamental cut-set formulation –Node-pair analysis. i-shifting.	2
2.4	Analysis using generalized branch model (node, loop and node pair analysis) –Tellegen's theorem.	2
3	**(13 hours)**	
3.1	Modeling Two-port networks - application examples-amplifiers, transmission lines, passive filters. Review of network parameter sets for two-port networks (z, y, h, g, T parameters, equivalent circuits and inter-relationship between parameters, Standard T- and pi networks. (Review may be done using assignments/homeworks).	2
3.2	Image parameter description of a reciprocal two-port network - Image impedance.	1
3.3	Characteristic impedance - propagation constant—derivation of characteristic impedance and propagation constant for T and Pi networks under sinusoidal steady state -- Attenuation constant and phase constant.	2

3.4	Filter terminology: Low pass, high pass, band-pass and band-reject filters. Gain characteristics. Constant k-derived low pass filter -- Comparison with ideal low-pass filter -- Prototype Low pass filter design.	2
3.5	m-derived low pass filter sections, m-derived half-sections for filter termination. m-derived half-sections for input termination. Half-pi termination for pi section filters.	2
3.6	Constant k- and m-derived high pass filters --Design. Constant k- band-pass filter -- Design of prototype bandpass filter -- Constant-k band-stop filter-effect of cascading multiple sections.	2
3.7	Resistive attenuators-Symmetric T and Pi section attenuators -- Lattice-section attenuator- Symmetrical bridged T-section attenuator - Asymmetrical T-Section and Pi-section attenuator.	2
4	**Network Functions (7 hours)**	
4.1	Review of Network functions for one port and two port networks: – calculation of network functions for ladder and general networks-poles and zeros for network functions-pole zero location for driving point and transfer functions.	2
	Impulse response of Network functions from pole-zero plots- Sinusoidal steady-state frequency response from pole-zero plots.	2
	Hurwitz polynomials – properties - Positive real functions – Properties of positive real functions – passivity-necessary and sufficient conditions for positive real functions - physical realizability.	3
5	**Synthesis of one port networks (9 hours)**	
5.1	Synthesis of reactive one - ports by Foster's and Cauer methods (forms I and II): Synthesis of R–C Network -- Properties of the R–C Impedance or R–L Admittance Function -- Foster Form-I of R–C Network -- Foster Form-II of R–C Network, Cauer Forms of R–C Network.	3
5.2	Synthesis of R–L Network -- Properties of R–L Function/R–C Admittance Function -- Foster Form-I of R–L Network -- Foster Form-II of R–L Network -- Cauer Form-I of R–L Network -- Cauer Form-II R–L Network.	3
5.3	Synthesis of L–C Networks -- Properties of L–C Immittance -- Foster Form-I of L–C Network -- Foster Form-II of L–C Network -- Cauer Form-I of L–C Network -- Cauer Form-II of L–C Network.	3