APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

(A State Government University)

B. Tech, 2024

Minor Degree in

POWER CONVERTERS & DRIVES

Offered By: Electrical Engineering

CURRICULUM

Minor (Power Converters & Drives)

Sl. No:	Semester	Course Code	Course Title (Course Name)	Credit Structure			SS	Total Marks		Credits	Hrs./ Week
				L	T	P		CIA	ESE		
1	3	MNEET309	Electric Circuit Analysis	3	1	0	5	40	60	4	4
2	4	MNEET409	Electrical Machines	3	0	2	5.5	40	60	4	5
3	5	MNEET509	Power Electronic Converters	3	1	0	5	40	60	4	4
4	6	MNEET609	Power Semiconductor Drives	3	0	0	4.5	40	60	3	3
Total							**20/21**			**15**	**15/17**

SEMESTER 3

ELECTRIC CIRCUIT ANALYSIS

Course Code	**MNEET309**	**CIE Marks**	40
Teaching Hours/Week (L:T:P)	3:1:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GXEST104 / GZEST204	Course Type	**Theory**

Course Objectives:

1. This course introduces circuit analysis techniques applied to dc and ac electric circuits in steady state and dynamic conditions.
2. This course serves as the most important prerequisite of almost all advanced courses in electrical engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**NETWORK THEOREMS**: Review of Kirchoff's laws - Mesh analysis – Nodal analysis - network theorems - Superposition theorem – Source transformation - Thevenin's theorem – Maximum power transfer theorem - DC and AC circuits with dependent and independent sources	11
2	**THREE-PHASE NETWORKS**: Review of 3-phase balanced system – active, reactive and apparent power in balanced star and delta - unbalanced system – 3-wire delta, 4-wire star, 3-wire star without neutral impedance (solution using Milman's method only) - active, reactive and apparent power in unbalanced star and delta - 3-phase power measurement using two-wattmeter method in balanced and unbalanced systems.	11
3	**STEADY STATE and TRANSIENT RESPONSE**: Laplace Transforms – inverse Laplace transforms - DC response of RL, RC and RLC circuits with initial conditions - complete solution using Laplace Transforms - Time constant – damping in RLC series circuit.	11
4	**TWO-PORT NETWORKS**: Z, Y, h and T parameters - conditions for symmetry & reciprocity – Relationship between parameters – interconnection of two-port networks – series, parallel and cascade connections – T and π networks.	11

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric Circuits & Networks	Suresh Kumar	Pearson	2008
2	Network Analysis	Van Valkenburg	Pearson	2019
3	Network Analysis and Synthesis	Ravish R Singh	McGraw Hill Education	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Circuit Analysis	Hayt and Kemmerly	McGraw Hill Education,	2013
2	Circuit Theory Analysis and Synthesis	Chakrabarti	Dhanpat Rai& Co.	2018
3	Engineering Network Analysis & Filter Design	Gopal G Bhise, Prem R Chadha, Durgesh Kulshreshtha	Umesh Publications	2012

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	15	10	10	40

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Apply circuit theorems to solve complex DC and AC electric networks	K3
CO2	Apply transformation from time domain to s-domain, solve dynamic electric circuits.	K3
CO3	Analyse three-phase networks in star and delta configurations under balanced and unbalanced conditions	K3
CO4	Describe two-port networks in terms of various parameters	K3

Note*:* K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3										3
CO3	3	3										3
CO4	3	3										3

MODEL QUESTION PAPER

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

Course Code: MNEET309

Course Name: ELECTRIC CIRCUIT ANALYSIS

Max. Marks: 60		Duration: 2 Hours 30 Minutes

PART A

		Answer all questions. Each question carries 3 marks	CO	Marks
1		For the circuit shown in figure (1), find the load impedance for maximum power transfer if i) the load impedance is complex and ii) if the load impedance is purely resistive.		(3)

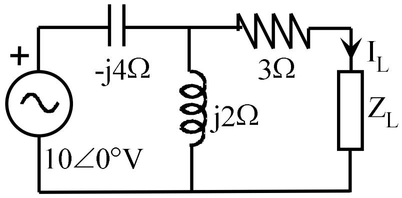

Figure (1)

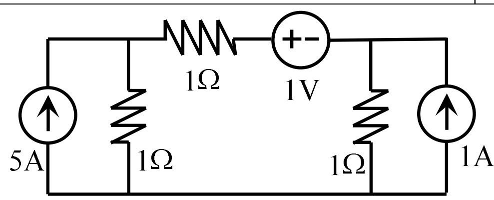

Figure (2)

2		For the circuit shown in figure (2), using source transformation technique, determine the equivalent circuit using a single voltage source and a resistance and hence find the current.		(3)
3		Define active power and reactive power in 3-phase circuits.		(3)
4		A 3-phase supply is connected to an unbalanced delta connected load with load impedances $1\angle 0°\Omega, 1\angle 90°\Omega$ & $1\angle -90°\Omega$. If the magnitude of the currents through each load impedance is 10A, find the active power consumed by the 3-phase load.		(3)
5		Determine the voltage v(t) across a 2Ω resistor, if the current is given by, $I(s) = \frac{2s+4}{s^2+4s+3}$.		(3)
6		Explain different types of damping in series RLC circuit.		(3)
7		Derive the condition for reciprocity of a 2-port network in terms of Z – parameters.		(3)
8		Derive expression for the equivalent T-parameters if two 2-port networks with T-parameters T_A and T_B are connected in cascade.		(3)

PART B

Answer any one full question from each module. Each question carries 9 marks

Module 1

9	a)	Find V_{AB} in the circuit shown in figure (3) using Thevenin's Theorem.		(5)

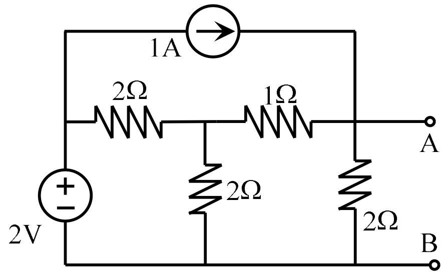

Figure (3)

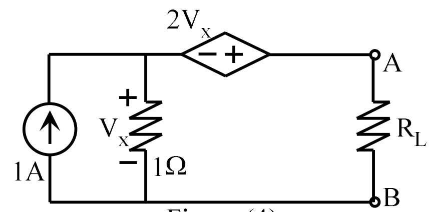

Figure (4)

	b)	For the circuit shown in figure (4), determine the value of R_L for maximum power transfer and hence find the maximum power.		(4)
10	a)	For the circuit shown in figure (5), find the current through 3+j4 impedance using Superposition theorem.		(5)

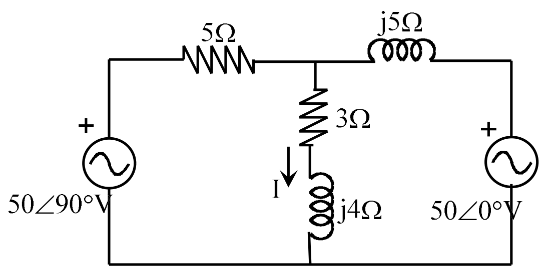

Figure (5)

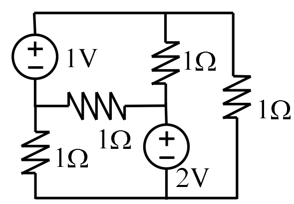

Figure (6)

	b)	For the circuit shown in figure (6), find the power supplied by 2V source using mesh analysis.		(4)
Module 2				
11		A 400V, 3-phase supply feeds an unbalanced 3-wire, star-connected load. The branch impedances of the load are $Z_R = 10\Omega$, $Z_Y = -j5\Omega$ and $Z_B = j15\Omega$. Calculate the line currents. Also find the apparent power, active power and reactive power absorbed by the load.	CO2	(9)

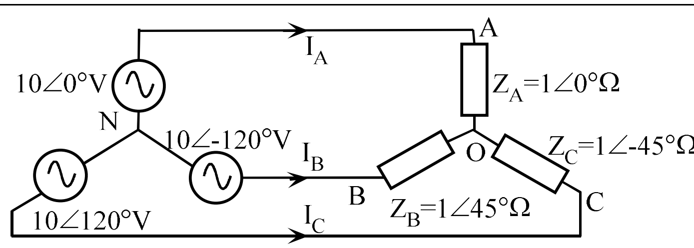

Figure (7)

12		For the 3-phase 3-wire system shown in figure (7), determine neutral shift voltage, V_{ON}, load phase voltages V_{AO}, V_{BO}, V_{CO} and line currents i_A, i_B, i_C.	CO2	(9)
Module 3				
13	a)	For the network shown in figure (8), the switch S is closed at t = 0. Find $i_1(t)$ and $i_2(t)$ for t > 0.		(5)
	b)	In the network shown in figure (9), switch S is opened at t=0. Determine i(t) for $t \geq 0$.		(4)

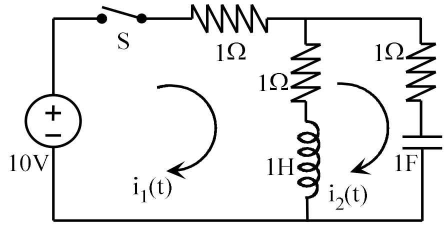

Figure (8)

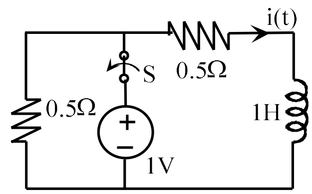

Figure (9)

14	a)	The switch K in the circuit shown in figure (10) has been at position 1 for a long time. At t = 0, the switch is moved to position 2. Determine the current flowing through the inductor for t > 0.		(6)

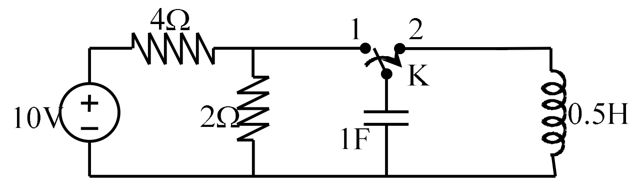

Figure (10)

	b)	An RLC series circuit with R =3 Ω, L =1 H and C = 1/2 F is excited by a DC voltage of 2V at t = 0. Find the current i(t) for t > 0.		(3)

Module 4

15	a)	Two sets of measurements are made on a two-port resistive circuit. The first set is made with port 2 open, and the second set is made with port 2 short-circuited. The results are as follows. Port 2 open: V_1 = 6V, I_1 = 2A, V_2 = 4V Port 2 shorted: V_1 = 6V, I_1 = 3A, I_2 = -1.5A Determine Z and h.		(5)
	b)	Port 2 of a two-port network with Z_{11} = 5Ω; Z_{12} = 2Ω; Z_{21} = 2Ω and Z_{22} = 3Ω is connected to a load resistance R_L = 1Ω. If port 1 is connected to a dc voltage source of 16V, find the power delivered to the load.		(4)
16	a)	For the circuit shown in figure (11), find the T – parameters.		(5)

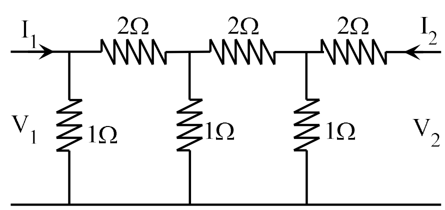

Figure (11)

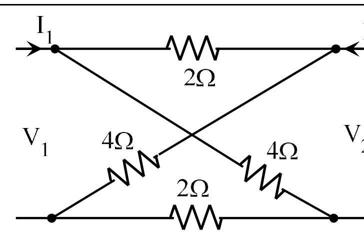

Figure (12)

	b)	For the circuit shown in figure (12), find the Z – parameters.		(4)

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SEMESTER 4

ELECTRICAL MACHINES

Course Code	**MNEET409**	**CIE Marks**	40
Teaching Hours/Week (L:T:P)	3:0:2	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	**Theory + Lab**

Course Objectives:

The purpose of the course is to provide the fundamentals of DC and AC machines giving emphasis to applications in engineering field

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	DC Machines - principle of operation of DC generator – concepts and comparison of lap and wave windings - emf equation - types of excitations - separately excited, shunt, series and compound generators - concept of armature reaction - open circuit characteristics (determination of critical field resistance and voltage build up) and load characteristics (external characteristics only) of shunt generators only - simple numerical problems. DC motors - Principle of operation - torque and speed equations – separately excited, shunt, series and compound motors – torque-speed characteristics of shunt and series motors – losses and efficiency - starting of shunt motor using 3-point starter - applications of dc motors - simple numerical problems.	11
2	Transformers – principle of operation – emf equation – constructional details – shell-type and core-type – ideal transformer – practical transformer - phasor diagram – equivalent circuit - voltage regulation - losses and efficiency - maximum efficiency – OC and SC tests – simple numerical problems.	11
3	Synchronous machines – constructional details of synchronous generator – principle of operation – types – emf equation – coil-span factor and distribution factor (no derivation) – open circuit and short circuit characteristics - armature reaction - voltage regulation of alternator at lagging and leading power factors – determination of voltage regulation by emf method – simple numerical problems - Principle of operation of synchronous motors - methods of starting	11
4	3-phase induction motors – constructional details - slip ring and squirrel cage types - principle of operation - rotating magnetic field (no derivation) – equivalent circuit - torque slip characteristics – no-load and blocked rotor tests – simple numerical problems - methods of starting – direct online, star delta, auto transformer and rotor resistance starting – single-phase induction motors – principle of operation – split-phase and capacitor-start induction motors.	11

<u>Experiment List</u>

<u>(Maximum 8 Experiments)</u>

Experiment No.	Experiment
1	Open circuit characteristics of DC shunt generator – determine critical field resistance and maximum voltage build up for given shunt field resistance
2	Load characteristics (V Vs I_L) of DC shunt generator
3	Load test on DC shunt motor and determine speed Vs torque characteristics
4	Load test on DC series motors and determine speed Vs torque characteristics
5	Open circuit and short circuit tests on 1-phase transformer Determine the equivalent circuit parameters Predetermine of voltage regulation and efficiency at full load and unity, 0.8 lag and 0.8 lead power factors.
6	Load test on 1-phase transformer at full-load and unity power factor – determine full load regulation and efficiency
7	Open circuit and short circuit tests on 3-phase alternator. Predetermine of voltage regulation at full load and unity, 0.8 lag and 0.8 lead power factors.
8	Load test on 3-phase squirrel cage induction motor and determine torque and efficiency at full load.
9	Load test on 3-phase slip-ring induction motor and determine torque and efficiency at full load
10	Load test on 1-phase induction motor and determine torque and efficiency at full load

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electrical Machinery	P.S. Bimbhra	Khanna Publishers	2020
2	Electric Machines	D P Kothari & I J Nagrath	Tata McGraw Hill	2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Electric Machinery	Fitzgerald A. E., C. Kingsley and S. Umans	McGraw Hill,	2020
2	Theory of Alternating Current Machinery	Langsdorf M. N	Tata McGraw Hill	2001
3	DC Machines & Transformers	K Murugesh Kumar	Vikas Publishing House	2004
4	Induction & Synchronous Machines	K Murugesh Kumar	Vikas Publishing House	2000
5	Theory & Performance of Electrical Machines	J.B. Gupta	S K Kataria	2013

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination-3 (Lab Examination)	Total
5	5	10	10	10	40

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Analyze the working of DC machines	K3
CO2	Analyze the working of 1-phase transformer	K3
CO3	Analyze the working of 3-phase synchronous machines	K3
CO4	Analyze the working of induction motors	K3

Note*:* K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2					2	2		3
CO2	3	3		2					2	2		3
CO3	3	3		2					2	2		3
CO4	3	3		2					2	2		3

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B. TECH MINOR DEGREE EXAMINATION, MONTH AND YEAR

Course Code: MNEET409

Course Name: ELECTRICAL MACHINES

Max. Marks: 60 — Duration: 2 Hours 30 Minutes

PART A

		Answer all questions. Each question carries 3 marks	CO	Marks
1		What are the necessary conditions for voltage build in a DC shunt generator?	CO1	(3)
2		Explain the significance of back emf in a DC motor.	CO1	(3)
3		List the characteristics of an ideal transformer.	CO2	(3)
4		Draw the phasor diagram of a 1-phase transformer delivering upf load.	CO2	(3)

5		Two alternators run on the same shaft (ie, runs at same speed). One generates voltage at 50Hz and the other at 40Hz. Find the maximum possible speed. Also find another possible speed.	CO3	(3)
6		Explain the effect of armature reaction of an alternator at zero power factor lagging.	CO3	(3)
7		What is the need for starter in a 3-phase induction motor?	CO4	(3)
8		Explain the working of a 1-phase split-phase induction motor.	CO4	(3)
		PART B		
		Answer any one full question from each module. Each question carries 9 marks		
		Module 1		
9	a)	Explain the construction of a DC machine with neat diagram.	CO1	(5)
	b)	A 400V DC shunt generator has a full load current of 190A. Its armature resistance is 0.08Ω; shunt field resistance 200Ω, iron and mechanical loss together 2000W. Find the full load efficiency.	CO1	(4)
10	a)	Draw and explain the speed – torque characteristics of DC series motor.	CO1	(4)
	b)	A 440V shunt motor takes 105A as armature current from the supply and runs at 1000rpm. The armature resistance is 0.15Ω. If the total torque developed is unchanged, calculate the speed and armature current if the magnetic field is reduced to 70% of the initial value.	CO1	(5)
		Module 2		
11	a)	Derive the emf equation of a 1-phase transformer.	CO2	(4)
	b)	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.	CO2	(5)
12	a)	Explain the voltage regulation of a 1-phase transformer.	CO2	(4)
	b)	A 25kVA, 3300/230V, 50Hz 1-phase transformer has iron loss of 300W and copper loss of 400W on full-load. (a) Find the efficiency of the transformer at half load at 0.8 power factor lagging. (b) At what load will the efficiency be maximum? Also, find the maximum efficiency.	CO2	(5)
		Module 3		
13	a)	Compare between cylindrical type and salient-pole type synchronous generators.	CO3	(4)
	b)	A 3-phase, 10-pole alternator has 2 slots/pole/phase on its stator with 10 conductors per slot. The air gap flux is sinusoidally distributed and equals 0.05Wb. The stator has a double layer winding with a coil span of 150°(electrical). If the alternator is running at 600rpm, calculate the emf generated/phase at no load.	CO3	(5)
14	a)	Explain the principle of operation of a synchronous motor.	CO3	(5)
	b)	A 3-phase, 230V(phase), 10A, delta connected synchronous generator has synchronous reactance X_s = 3Ω, determine the full load voltage regulation at zero power factor lag and lead.	CO3	(4)
		Module 4		
15	a)	Explain the working of a 3-phase induction motor. Also, explain the torque Vs speed characteristics of induction motor.	CO4	(5)
	b)	In a 6 pole, 3 phase, 50Hz motor with star-connected rotor, the rotor resistance per phase is 0.3Ω, the reactance at standstill is 1.5 Ω per phase and an emf	CO4	(4)

		between the slip rings on open circuit is 175V. Calculate i) slip at a speed of 950 rpm ii) rotor emf per phase iii) rotor frequency and reactance at a speed of 950 rpm.		
16	a)	Explain the working of a star-delta starter in a 3-phase induction motor.	CO4	(4)
	b)	A 10KW 400V 4pole delta connected squirrel cage induction motor gave the following test results: No load test: 400V 8A 250W Blocked rotor test: 90V 35A 1350W The stator resistance is 0.72Ω/ph. Determine the equivalent circuit parameters.	CO4	(5)

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SEMESTER 5

POWER ELECTRONIC CONVERTERS

Course Code	**MNEET509**	**CIE Marks**	40
Teaching Hours/Week (L:T:P)	3:0:2	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	**Theory + Lab**

Course Objectives:

1. To give a strong foundation on power converters,
2. To motivate students to design and implement power electronic converters having high efficiency, small size, high reliability and low cost

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Power semiconductor devices and their symbols (power diode, SCR, Power MOSFET and IGBT) – structure of SCR – forward blocking, forward conduction and reverse blocking - static characteristics - two transistor analogy – turn-on methods - gate triggering circuits – RC and UJT firing circuits - comparison of power diode, SCR, Power MOSFET and IGBT.	11
2	Controlled rectifiers – half-wave controlled rectifier with R load – single phase fully controlled and half-controlled bridge rectifier with R (discontinuous) and RLE loads (continuous conduction only) – waveforms - output voltage equation (continuous conduction) – 3-phase fully-controlled bridge rectifier with RLE load (continuous conduction) – waveforms – output voltage equation – simple numerical problems	11
3	AC voltage controllers (ACVC) – 1-phase full-wave ACVC with R, L & RL loads – waveforms – RMS output voltage – input power factor - sequence control (two stage) with R load. Inverters – voltage source inverters – single phase full bridge inverter with R, L & RL loads – waveforms – RMS output voltage – fundamental RMS output voltage - voltage control in inverters – single pulse width modulation – sine PWM – modulation index & frequency modulation ratio – fundamental RMS output voltage - 3-phase bridge inverter with star and delta connected R load –180° conduction mode.	11
4	DC-DC converters – step down and step up choppers – single-quadrant (Type A and B), two-quadrant (Type C and D) & four quadrant chopper (class E) – pulse width modulation & current limit control in dc-dc converters. Switching regulators – buck, boost & buck-boost – operation in continuous conduction mode – waveforms – design of filter inductance and capacitance.	11

Experiment List

(Maximum 8 Experiments)

Experiment No.	Experiment
1	Static characteristics of SCR
2	UJT triggering circuit
3	1-phase fully-controlled / semi-controlled rectifier with R load
4	1-phase AC voltage controller
5	Chopper controlled DC motor
6	Simulation of 1-phase fully controlled and semi controlled rectifier
7	Simulation of 3-phase fully controlled bridge rectifier
8	Simulation of buck, boost and buck-boost converter
9	Simulation of 1-phase full bridge square wave inverter
10	Simulation of 1-phase sine PWM inverter

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Power Electronics – Converters Application and Design	Mohan, Undeland, Robbins	Wiley-India	2022
2	Power Electronics – Circuits, Devices and Applications	Muhammad H. Rashid	Pearson Education	2017
3	Power Electronics	P.S. Bimbhra	Khanna Publishers	2024

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Power Electronics – Essentials & Applications	L. Umanand	Wiley-India	2009
2	Power Electronics- Principles and Applications	Joseph Vithayathil	Tata McgrawHill	2010
3	Power Electronics	Cyril W Lander	McGrawHill	1993

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination-3 (Lab Examination)	Total
5	5	10	10	10	40

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Explain the operation, control and characteristics of power semiconductor devices.	K2
CO2	Analyze the working of the various types of controlled rectifiers	K3
CO3	Explain the working of AC voltage controllers and analyze its operation.	K3
CO4	Describe the operation and voltage control techniques of inverters.	K3
CO5	Analyze the working of dc-dc converters	K3

Note*:* K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2	2	2				2	2		3
CO2	3	3	2	2	3				2	2		3
CO3	3	3	2	2	3				2	2		3
CO4	3	3	2	2	3				2	2		3
CO5	3	3	3	2	3				2	2		3

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B. TECH MINOR DEGREE EXAMINATION, MONTH AND YEAR

Course Code: MNEET509

Course Name: POWER ELECTRONIC CONVERTERS

Max. Marks: 60		Duration: 2 Hours 30 Minutes

PART A

		Answer all questions. Each question carries 3 marks	CO	Marks
1		Explain the static characteristics of SCR.	CO1	(3)
2		Explain the working of RC triggering circuit with necessary waveforms.	CO1	(3)
3		Draw the source current and output voltage waveforms of a 1-phase fully-controlled bridge rectifier with R load at a firing angle of 90°.	CO2	(3)
4		Derive the expression for the average output voltage of a 1-phase semi-converter with continuous and ripple-free load current.	CO2	(3)
5		Explain the working of a 1-phase AC voltage controller with R load with necessary waveforms.	CO3	(3)
6		Explain the working of a 1-phase full-bridge inverter with L load with necessary waveforms.	CO4	(3)
7		Derive the expression for the average output voltage of a boost converter.	CO5	(3)
8		Explain the current limit control in a DC-DC converter.	CO5	(3)

PART B

Answer any one full question from each module. Each question carries 9 marks				
Module 1				
9	a)	Explain the two-transistor analogy of SCR.	CO1	(5)
	b)	Explain any two turn-on methods of SCR.	CO1	(4)
10	a)	Explain the working of a UJT triggering circuit.	CO1	(4)
	b)	Draw the symbols of IGBT and power MOSFET and list any 3 comparisons.	CO1	(5)
Module 2				
11	a)	Explain the working of a 1-phase fully controlled bridge rectifier with necessary waveforms (source current and load current). Assume continuous and ripple-free load current.	CO2	(5)
	b)	A 1-phase semi-converter is operated from a source of 120V and 50Hz, which supplies to a load resistance of 10Ω. If the average output voltage is 25% of the maximum average output voltage, determine i) the firing angle α and ii) the average load current I_{dc}.	CO2	(4)
12		Explain the working of a 3-phase fully-controlled bridge rectifier with necessary waveforms (source current, load voltage) at a firing angle of 30°. Assume continuous and ripple-free load current.	CO2	(9)
Module 3				
13	a)	Explain the sine PWM technique in 1-phase full-bridge inverters. Define the terms modulation index and frequency modulation ratio.	CO4	(5)
	b)	A 1-phase full wave ac voltage controller has a resistive load of 20Ω while the input voltage is 220V at 50Hz. If the firing angles of each of the anti-parallel thyristors are 90°, calculate i) the RMS value of the output voltage and ii) the input power factor.	CO3	(4)
14		Explain the working of a 3-phase full-bridge inverter with star connected R-load in 180° conduction mode. Also, draw the line voltages and phase voltages across the load showing the devices conducting during each period.	CO4	(9)
Module 4				
15	a)	Explain the working of a four-quadrant chopper (type E).	CO5	(6)
	b)	Explain the working of two-quadrant chopper (type C).	CO5	(3)
16	a)	Explain the working of a buck-boost converter with necessary waveforms. Assume the load voltage is ripple-free.	CO5	(4)
	b)	A buck converter topology was used to obtain the required dc load voltage output of 5V from a dc input of 12V. The peak-to-peak output ripple was restricted to 20mV. The switching frequency is 25kHz. For maintaining the peak-to-peak ripple current of inductor to 0.8A, determine i) the duty cycle ii) the filter inductance L and capacitance C.	CO5	(5)
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SEMESTER 6

POWER SEMICONDUCTOR DRIVES

Course Code	**MNEET609**	**CIE Marks**	40
Teaching Hours/Week (L:T:P)	3:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	**Theory**

Course Objectives:

To impart knowledge about the DC and AC motor drives and its applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to electric drives – Block diagram – advantages of electric drives – classification of load torques – four quadrant operation - fundamental torque equation – components of load torque - Steady state stability – calculation of time in transient operation – concept of closed loop control of motor drives.	9
2	DC motor drives- constant torque and constant power operation - separately excited dc motor drives using single phase and 3-phase fully controlled converters. Chopper controlled separately excited DC drives - single quadrant chopper drives (class A and B) - regenerative braking control - two quadrant chopper drives (class C) - four quadrant chopper drives (class E).	9
3	Induction Motor Drives- speed control of 3-phase induction motor - Stator voltage control –Stator voltage and frequency control - voltage source inverter control – static rotor resistance control – slip power recovery control schemes – static Kramer drive – static Scherbius drive - sub synchronous and super synchronous speed variations.	9
4	Synchronous motor drives – variable frequency control- open loop inverter fed synchronous motor drive – self-controlled synchronous motor drive. Permanent magnet synchronous motor (PMSM) – principle of operation and control – Brushless DC motor drives (BLDC) – principle of operation and control – Switched reluctance motor (SRM) – principle of operation and control – converter circuit.	9

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Fundamentals of electric drives	G.K. Dubey	Pearson Education	2002
2	Electric Drives	Vedam Subrahmanyam	MC Graw Hill Education	2017

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Power electronics	P. S. Bimbhra	Khanna publishers	2022
2	Modern power electronics and AC drives	Bimal K. Bose	Pearson Education	2015
3	Power semiconductor control drives	Dubey G. K.	Prentice Hall	1989
4	Power Electronics and Motor Control	W. Shepherd, L. N. Hulley and D. T. Liang	Cambridge University Press	2015

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	15	10	10	40

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Describe the transient and steady state aspects electric drives	K3
CO2	Apply the appropriate configuration of controlled rectifiers for the speed control of DC motors	K3
CO3	Analyse the operation of chopper-fed DC motor drive in various quadrants	K3
CO4	Describe the various speed control techniques of induction motors	K3
CO5	Explain the different speed control methods of synchronous motor drives	K3
CO6	Describe the principle of operation and the speed control of special electrical machine drives.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

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

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B. TECH MINOR DEGREE EXAMINATION, MONTH AND YEAR

Course Code: MNEET609

Course Name: POWER SEMICONDUCTOR DRIVES

Max. Marks: 60 | Duration: 2 Hours 30 Minutes

PART A

		Answer all questions. Each question carries 3 marks	CO	Marks
1		Explain the block diagram of an electric drive.	CO1	(3)
2		Explain the classification of load torques.	CO1	(3)
3		Describe the regenerative control in a separately excited DC motor.	CO2	(3)
4		Explain the working of a two-quadrant (type C) chopper.	CO3	(3)
5		Why the speed control of a 3-phase induction motor with constant supply voltage and reduced supply frequency is not preferred?	CO4	(3)
6		Explain the static rotor resistance control of a 3-phase induction motor.	CO4	(3)
7		List the advantages of self-control of synchronous motor.	CO5	(3)
8		List the applications of switched reluctance motor.	CO6	(3)

PART B

Answer any one full question from each module. Each question carries 9 marks

		Module 1		
9	a)	Explain the four-quadrant operation of a motor driving a hoist load with necessary sketches.	CO1	(5)
	b)	A drive has following parameters: - $J=10 kg\text{-}m^2$, $T=100-0.1N$ and $T_l=0.05N$ where N is the speed in rpm. Initially the drive is operating in steady state. Now it is to be reversed. For this motor characteristics is changed to $T = -100-0.1N$. Calculate the time of reversal.	CO1	(4)
10	a)	Explain the different components of load torques.	CO1	(4)
	b)	Explain the steady-state stability in a drive using speed-torque characteristics.	CO1	(5)
		Module 2		
11	a)	Derive an expression relating speed and torque of 1-phase full-converter fed separately excited DC motor drive operating in continuous conduction mode.	CO2	(5)
	b)	A 220V, 960rpm, 12.8A SEDCM has $R_a=2\Omega$ and $L_a=150mH$. It is fed from a 3-phase fully controlled rectifier with source voltage of 400V, 50Hz. Calculate i) motor torque for $\alpha=60°$ and speed = 600rpm ii) motor speed for $\alpha=60°$ and T = 20Nm.	CO2	(4)
12	a)	Explain the working of a four-quadrant chopper fed separately excited DC motor.	CO3	(5)
	b)	A 200V, 875rpm, 150A separately excited DC motor has an armature resistance of 0.06Ω. It is fed from a 1-phase fully-controlled rectifier with an ac source voltage of 220V, 50Hz. Assuming continuous conduction, calculate firing angle for rated motor torque and 750rpm.	CO2	(4)
		Module 3		
13	a)	Using torque-speed curve, explain the stator voltage control of a 3-phase induction motor.	CO4	(5)

	b)	A 440V, 3-phase, 50Hz, 6-pole, 945rpm, delta connected induction motor has following parameters referred to the stator: $R_s = 2\Omega$, $R_r' = 2\Omega$, $X_s = 3\Omega$, $X_r' = 4\Omega$. When driving a fan load at rated voltage it runs at rated speed. The motor speed is controlled by stator voltage control. Determine motor speed, current and torque for the terminal voltage of 280V.	CO4	(4)
14	a)	Explain the working of static Kramer drive for the speed control of a 3-phase slip-ring induction motor and derive the expression for slip.	CO4	(5)
	b)	A 3-phase, 3560rpm, 460V, 60Hz, 2-pole, star connected induction motor has R_s=0.2Ω, R_r'=0.18Ω, X_s=0.13Ω, X_r'=0.2Ω . The motor is controlled by a constant volt to Herts ratio corresponding to the rated voltage and rated frequency. Calculate the maximum torque and the corresponding slip for 30Hz.	CO4	(4)
Module 4				
15	a)	Explain the open loop v/f control of synchronous motor drive.	CO5	(4)
	b)	Explain the principle of operation of a brushless DC motor.	CO6	(5)
16	a)	Explain the working of a self-controlled synchronous motor drive employing load commutated current source inverter.	CO5	(5)
	b)	Explain the principle of operation of a switched reluctance motor.	CO6	(4)
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