Hall Ticket No: | | | | | | | | | | |

Question Paper Code: AEE013

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER

B.Tech VI Semester End Examinations (Regular), Apr – 2020

Regulation: IARE–R16

SOLID STATE ELECTRIC MOTOR DRIVES

(Electrical and Electronics Engineering)

Time: 3 hours **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1	a)	Derive an expression relating speed and torque of a single phase full converter fed separately excited DC motor drive operating in the continuous current mode	[7M]
	b)	The speed of a 15hp, 220V, 1000 rpm dc series motor is controlled using a single-phase half controlled bridge rectifier. The combined armature and field resistance is 0.2 Ω. Assuming continuous and ripple free motor current and speed of 1000 rpm and K=0.03 Nm/Amp2 determine a) motor current, b) motor torque for a firing angle α=30° AC source voltage is 250 V.	[7M]
2	a)	Explain the operation of three phase full controlled rectifier fed dc series motor drives with waveforms and characteristics	[7M]
	b)	A 230V, 1500 rpm, 20A separately excited dc motor is fed from 3-phase full converter. Motor armature resistance is 0.6 Ω. Full converter is connected to 400V, 50Hz source through a delta-star transformer. Motor terminal voltage is rated when converter firing angle is zero. Calculate the transformer phase turns-ratio from primary to secondary	[7M]

UNIT – II

3	a)	Explain the principle of operation of a dual converter in a circulating current mode. How the same is used for speed control of DC drive	[7M]
	b)	A DC chopper is used to control the speed of a separately excited DC motor. The DC supply voltage is 220V, armature is 0.2 ohm and motor constant is 0.08V/rpm. This motor drives a constant torque requiring an average armature current of 25A. Determine the (a) the range of speed control, (b) the range of duty cycle.	[7M]
4	a)	Deduce the mathematical expression for minimum and maximum currents for a class A chopper operated DC motor with back emf.	[7M]
	b)	A 220V, 200A, 800 rpm dc separately excited motor has an armature resistance of 0.05Ω. The motor armature is fed from a variable voltage source with an internal resistance of 0.03 Ω. Calculate internal voltage of the variable voltage source when the motor is operating in regenerative braking at 80% of the rated motor torque and 600rpm.	[7M]

UNIT – III

5 a) Explain the four quadrant closed loop control of induction motor drive using AC voltage controller [7M]

b) A 3-phase, 400V, 50Hz, 4-pole, 1440 rpm delta connected squirrel cage induction motor has a full load torque of 48.13 N-m. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate the motor torque at 1200rpm. [7M]

6 a) Explain the operation of induction motor with constant voltage and different frequencies [7M]

b) A three phase, 50KW, 1475rpm, 420V, 50Hz, 4 pole, star connected induction motor has the following data: Rs = 0.4Ω, Rr' = 0.21Ω, Xs = 0.95Ω, Xr' = 32Ω. If the frequency is increased to 58Hz by frequency control determine [7M]

i. The slip at maximum torque
ii. The speed at maximum torque
iii. The breakdown torque

UNIT – IV

7 a) Draw the speed-torque characteristics of a rotor resistance controlled induction motor and explain the effect of rotor resistance variation [7M]

b) A 3 phase, 400V, 6 pole, 50Hz, delta connected, slip ring induction motor has rotor resistance of 0.2Ω and leakage reactance of 1Ω per phase referred to stator. When driving a fan load it runs at full load at 4% slip what resistance must be inserted in the rotor circuit to obtain a speed of 850 rpm neglect stator impedance and magnetizing branch. Stator to rotor turns ratio is 2.2 [7M]

8 a) Explain the indirect methods of vector control of induction motor [7M]

b) The wound rotor motor is rated at 30kw, 1170rpm, 460V, 60Hz. The open circuit voltage is 400V, and the load resistor is 0.5Ω. if the chopper frequency is 200Hz, calculate the time Ton so that the motor develops a torque of 200Nm at 900rpm [7M]

UNIT – V

9 a) Describe self-controlled and a loop commutated inverter controlled synchronous motor drives in detail and compare them [7M]

b) A 6MW, 3-ph, 11KV,Y connected, 6 pole, 50Hz, 0.9(lead) pf synchronous motor has Xs=9ohm, Rs=0, rated field current is 50A. Machine is controlled by variable frequency control at constant V/F ratio upto the base speed and at constant V above base speed determine the Torque and field current for the rated armature current, 750rpm and 0.8 leading pf. [7M]

10 a) Explain the operation of a open loop V/f control of multiple synchronous motor with schematic diagram [7M]

b) A 6MW, 3-phase, 11KV, star connected, 6-Pole, 50Hz, 0.9 (leading) power factor synchronous motor has Xs = 8 Ω and Rs = o. Rated field current is 45A. Machine is controlled by variable frequency control at constant (v/f) ratio up to the base speed and at constant V above base speed. Determine, [7M]

i) Armature current and power factor for regenerative braking power output of 4.2MVA at 700 rpm and rated field current,
ii) Torque and field current for regenerative braking operation at rated armature current, 1400 rpm and unity power factor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE OBJECTIVES:

The course should enable the students to:

I	Demonstrate DC drives through phase controlled rectifiers and choppers.
II	Analyze operating principle of four quadrant DC drives.
III	Illustrate the speed control of induction motors through various parameters.
IV	Outline the separate and self control of synchronous motors.

COURSE OUTCOMES (COs):

CO 1	Analyze the speed control of DC motors with phase controlled rectifiers
CO 2	Describe the four quadrant operation of DC Drive with dual converter and operation of DC drives with choppers
CO 3	Apply the variable voltage and variable frequency operation of induction motors with suitable converters
CO 4	Understand the speed control of induction motor through static rotor resistance control and vector control
CO 5	Demonstrate the speed control of synchronous motor with suitable converters

COURSE LEARNING OUTCOMES (CLOs):

AEE013.01	Understand the speed control of DC motors with single phase controlled rectifiers
AEE013.02	Analyze the speed control of DC motors with three phase controlled rectifiers
AEE013.03	Describe the speed torque characteristics of DC motors with variation in firing angle of the controlled rectifiers
AEE013.04	Demonstrate the motoring and braking operations of DC motor drives
AEE013.05	Analyze the four quadrant operation of DC Drive with dual converter and closed loop operation
AEE013.06	Describe the operation of chopper fed DC motors
AEE013.07	Apply the variable voltage operation of induction motors with AC voltage controllers
AEE013.08	Analyze the variable frequency operation of induction motors with voltage source inverters and current source inverters
AEE013.09	Describe the variable frequency operation of induction motors with cycloconverters and closed loop operations
AEE013.10	Understand the speed control of induction motor through static rotor resistance control
AEE013.11	Demonstrate the vector control operation of induction motor with direct methods
AEE013.12	Describe the vector control operation of induction motor with indirect methods
AEE013.13	Analyze the speed control of synchronous motor with voltage source inverters and current source inverters

AEE013.14	Understand the speed control of synchronous motor with variable frequency control using cycloconverters
AEE013.15	Demonstrate the closed loop control of synchronous motors with block diagram
AEE013.16	Apply the concept of solid state electric drives to solve real time world applications
AEE013.17	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations

MAPPING OF SEMESTER END EXAMINATION - COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	AEE013.01	Understand the speed control of DC motors with single phase controlled rectifiers	CO 1	Understand
	b	AEE013.03	Describe the speed torque characteristics of DC motors with variation in firing angle of the controlled rectifiers	CO 1	Understand
2	a	AEE013.02	Analyze the speed control of DC motors with three phase controlled rectifiers	CO 1	Remember
	b	AEE013.03	Describe the speed torque characteristics of DC motors with variation in firing angle of the controlled rectifiers	CO 1	Understand
3	a	AEE013.05	Analyze the four quadrant operation of DC Drive with dual converter and closed loop operation	CO 2	Understand
	b	AEE013.06	Describe the operation of chopper fed DC motors	CO 2	Understand
4	a	AEE013.06	Describe the operation of chopper fed DC motors	CO 2	Understand
	b	AEE013.04	Demonstrate the motoring and braking operations of DC motor drives	CO 2	Understand
5	a	AEE013.07	Apply the variable voltage operation of induction motors with AC voltage controllers	CO 3	Understand
	b	AEE013.07	Apply the variable voltage operation of induction motors with AC voltage controllers	CO 3	Understand
6	a	AEE013.08	Analyze the variable frequency operation of induction motors with voltage source inverters and current source inverters	CO 3	Understand
	b	AEE013.09	Describe the variable frequency operation of induction motors with cycloconverters and closed loop operations	CO 3	Understand
7	a	AEE013.10	Understand the speed control of induction motor through static rotor resistance control	CO 4	Remember
	b	AEE013.10	Understand the speed control of induction motor through static rotor resistance control	CO 4	Understand
8	a	AEE013.12	Describe the vector control operation of induction motor with indirect methods	CO 4	Understand
	b	AEE013.10	Understand the speed control of induction motor through static rotor resistance control	CO 4	Understand
9	a	AEE013.13	Analyze the speed control of synchronous motor with voltage source inverters and current source inverters	CO 5	Understand
	b	AEE013.15	Demonstrate the closed loop control of synchronous motors with block diagram	CO 5	Understand

10	a	AEE013.14	Understand the principle of operation of three phase voltage source inverters and waveforms	CO 5	Understand
	b	AEE013.15	Demonstrate the closed loop control of synchronous motors with block diagram	CO 5	Understand

Signature of Course Coordinator **HOD, EEE**