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)	Describe the operation of single phase semi controlled rectifier control of DC series motor and obtain the expression for motor speed for continuous mode of operation	[7M]
	b)	A 1ϕ semi converter is operated from 220 V, 50 Hz supply. It is used for controlling the speed of a separately excited dc motor whose armature resistance is negligible. When the firing angle is 60° the motor is rotating at a speed of 800 rpm. The armature is coupled to constant torque load. The firing angle for a speed of 600 rpm is	[7M]
2	a)	Explain the motoring and braking operation of three phase fully controlled rectifier control of dc separately excited motor with aid of diagrams and waveforms. Also obtain the expression for motor terminal voltage speed.	[7M]
	b)	A 600V, 1500rpm, 80A separately excited dc motor is fed through a three phase semi converter from 3-phase 400V supply. Motor armature resistance is 1Ω the armature current assumed constant. For a firing angle of 45^0 at 1200rpm, compute the rms value of source and thyristor currents, average value of thyristor current and the input supply power factor	[7M]

UNIT – II

3	a)	Explain how four-quadrant operation is achieved by dual converter each of 3ϕ full wave configuration for DC separately excited motor.	[7M]
	b)	A 220V, 970rpm, 100A DC separately excited motor as an armature resistance of 0.05ohm. It is braked by plugging from an initial speed of 1000rpm. Calculate the resistance to be placed in armature circuit to limit breaking current to twice the full load value. Breaking torque and torque when the speed has fallen to zero.	[7M]
4	a)	Distinguish between class A and class B choppers with suitable examples of speed control of motors	[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 (a) the range of speed control, (b) the range of duty cycle.	[7M]

UNIT – III

5 a) Explain the analysis and performance of induction motor with equivalent circuit diagram. [7M]

b) A three phase SCIM drives a blower type load. No load rotational losses are negligible. Show that rotor current is maximum when the motor runs at a slip of 1/3. Find also an expression for maximum rotor current [7M]

6 a) Explain in detail the speed control scheme for a three phase induction motor using PWM inverter [7M]

b) A three phase squirrel cage induction motor is developing torque of 1500 synchronous watts at 50 Hz and 1440 rpm (synchronous speed is 1500 rpm). If the motor frequency is increased to 75Hz using constant power mode, determine the new value of torque developed by the motor at constant slip. [7M]

UNIT – IV

7 a) Explain the closed loop operation of static rotor resistance control of induction motor [7M]

b) A 440V, 50Hz, 6 pole star connected wound rotor motor has the following parameters. R_S=0.5 ohm, R'r=0.4 ohm, X_S=X_r'=1.2 ohm, Xm=50 ohm, stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty ratio of zero. Calculate the value of external resistance. How duty ratio should be varied with speed so that the motor accelerates at maximum torque. [7M]

8 a) Explain the park and clark transformation matrix [7M]

b) If 40Ω is the resistance and 0.75 is the duty cycle for the induction motor speed control using chopper, what is the effective value of resistance Re [7M]

UNIT – V

9 a) Draw and explain the block diagram of a closed loop synchronous motor drive fed from VSI [7M]

b) A 500KW, 3-ph, 3.3KV, 50Hz, 0.8(lag) pf, 4 pole star connected synchronous motor has a following parameters. Xs=15 ohm, Rs=0, rated field current is 10A calculate [7M]

i. Armature current and pf at half the rated torque and rated field current

ii. Field current to get upf at the rated torque.

10 a) Describe self-controlled mode of operation of a synchronous motor drive in detail [7M]

b) A3 phase, 400V, 50Hz, 6 pole, star connected round-rotor synchronous motor has Z_S=0+j2Ω. Load torque, proportional to speed squared, is 340N- m at rated synchronous speed. The speed of the motor is lowered by keeping V/f constant and maintaining unity Pf by field control of the motor. For the motor operation at 600rpm, calculate a) supply voltage b) armature current. [7M]

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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**