

# Faculty of Engineering

## End Semester Examination May 2025

### EE3CO60 Electrical Machines

<b>Programme</b>	:	B.Tech.	<b>Branch/Specialisation</b>	:	EE
<b>Duration</b>	:	3 hours	<b>Maximum Marks</b>	:	60

**Note:** All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary.  
 Notations and symbols have their usual meaning.

<b>Section 1 (Answer all question(s))</b>				<b>Marks CO BL</b>
<b>Q1.</b> What is the primary function of a transformer?				1    1    1
<input type="radio"/> Convert DC to AC	<input checked="" type="radio"/> Step up or step down AC voltage			
<input type="radio"/> Store electrical energy	<input type="radio"/> Convert mechanical energy to electrical energy			
<b>Q2.</b> What is the main advantage of an autotransformer over a conventional two-winding transformer?				1    1    2
<input type="radio"/> Lower efficiency	<input type="radio"/> Higher weight			
<input checked="" type="radio"/> Lower copper loss	<input type="radio"/> More core losses			
<b>Q3.</b> Which component in a DC machine is responsible for the mechanical rectification of current?				1    1    1
<input checked="" type="radio"/> Commutator	<input type="radio"/> Armature			
<input type="radio"/> Brushes	<input type="radio"/> Field winding			
<b>Q4.</b> What is the purpose of a starter in a DC motor?				1    2    2
<input type="radio"/> To increase motor speed	<input type="radio"/> To control armature reaction			
<input checked="" type="radio"/> To limit the starting current	<input type="radio"/> To increase efficiency			
<b>Q5.</b> What happens when the slip of an induction motor is zero?				1    2    2
<input type="radio"/> The motor stops	<input checked="" type="radio"/> The rotor runs at synchronous speed			
<input type="radio"/> The torque is maximum	<input type="radio"/> The motor operates as a generator			
<b>Q6.</b> The maximum torque in an induction motor occurs when:				1    3    3
<input type="radio"/> Slip is zero	<input checked="" type="radio"/> Rotor resistance equals rotor reactance			
<input type="radio"/> Supply frequency is maximum	<input type="radio"/> The motor runs at synchronous speed			
<b>Q7.</b> What is the primary function of a synchronous generator?				1    1    1
<input type="radio"/> Convert DC to AC	<input checked="" type="radio"/> Convert mechanical energy to AC electrical energy			
<input type="radio"/> Convert AC to DC	<input type="radio"/> Store electrical energy			
<b>Q8.</b> Which of the following methods of obtaining voltage regulation of a synchronous machine is also called 'general method'?				1    3    1
<input type="radio"/> EMF method	<input type="radio"/> MMF method			
<input checked="" type="radio"/> Zero power factor method	<input type="radio"/> Saturated synchronous – reactance method			
<b>Q9.</b> What is the primary reason synchronous motors are not self-starting?				1    2    2
<input type="radio"/> High resistance in rotor winding	<input checked="" type="radio"/> Lack of starting torque			
<input type="radio"/> Low efficiency	<input type="radio"/> High mechanical losses			

**Q10.** What is the purpose of damper windings in a synchronous motor?

1 4 1

- To increase efficiency
- To prevent hunting and assist in starting
- To improve voltage regulation
- To control speed

### Section 2 (Answer all question(s))

**Q11.** What will happen if primary of the transformer is connected to a DC supply?

Marks CO BL  
2 1 1

Rubric	Marks
Reason if primary of transformer connected to a DC supply.	2

**Q12.** Explain the working principle, construction, and phasor diagram of a transformer.

3 1 1

Rubric	Marks
Working principle of a transformer.	1
Construction of a transformer	1
Phasor diagram of a transformer.	1

**Q13. (a)** Derive the EMF equation of a transformer and explain voltage regulation.

5 3 3

Rubric	Marks
Derive the EMF equation of a transformer	3
Explain voltage regulation with formula	2

(OR)

- (b)** A transformer is rated at 100 KVA. At full load its copper loss is 1200 watts and iron losses are 960 W. Calculate:
- (i) Efficiency at full load unity Power factor
  - (ii) Efficiency at half load, 0.8 power Factor lagging
  - (iii) Efficiency at 75% full load, 0.7 pf lagging
  - (iv) The load KVA at which maximum efficiency occurs
  - (v) The maximum efficiency at 0.85 pf lagging

Rubric	Marks
(a) Efficiency at full load unity Power factor	1
(b) Efficiency at half load, 0.8 power Factor lagging	1
(c) Efficiency at 75% full load, 0.7 pf lagging	1
(d) The load KVA at which maximum efficiency occurs	1
(e) The maximum efficiency at 0.85 pf lagging	1

### Section 3 (Answer all question(s))

**Q14.** What do you mean by back e.m.f in DC motor ?

Marks CO BL  
2 1 1

Rubric	Marks
Definition of back EMF	1
Back EMF role in DC motor	1

**Q15.** Explain the methods of speed control in D.C. motors.

3 2 2

Rubric	Marks
Types of different methods	1.5
Explanation of any one methods	1.5

**Q16. (a)** Derive the expression for torque in a D.C motor. Draw the torque-armature current, speed armature current and torque speed characteristic in DC series motor.

5 3 1

Rubric	Marks
Torque derivation of DC Motor	2
DC Series motor characteristics	3

(OR)

- (b)** A 4 pole Lap wound armature has 144 slots with two coil sides per slot, each coil having two turns. if the flux per pole is 20mwb and the armature rotates at 720 rpm, what is the induced voltage?

Rubric	Marks
Correct formulas	2
Correct calculations	3

#### Section 4 (Answer all question(s))

Marks CO BL

**Q17.** Explain the construction and working principle of a three-phase induction motor.

2 1 1

Rubric	Marks
Construction of induction motor	1
Working principle of induction motor	1

**Q18.** Explain the phenomena of cogging and crawling in a three-phase induction motor. How can these issues be prevented?

3 2 2

Rubric	Marks
Cogging & Crawling explanation	2
Prevention methods	1

**Q19. (a)** Derive the torque equation of a three-phase induction motor and explain its torque-slip characteristics.

5 3 3

Rubric	Marks
Torque equation derivation	2
Torque-slip characteristics	3

(OR)

- (b)** A 3-phase, 440 V induction motor is wound for 4 poles and is supplied from a 50 Hz supply system. Calculate the speed of the motor when percentage slip is 5%.

Rubric	Marks
Correct Formula for slip Calculation	2
Correct calculations	3

### Section 5 (Answer all question(s))

**Marks CO BL**

**Q20.** Explain hunting in salient pole synchronous generator. How can hunting be minimized?

2 2 2

<b>Rubric</b>	<b>Marks</b>
Definition of hunting	1
Methods to minimize	1

**Q21.** Explain parallel operation of synchronous generators. Explain the conditions required for synchronization and the effects of incorrect synchronization.

<b>Rubric</b>	<b>Marks</b>
Parallel operation of synchronous generator	2
conditions for synchronization and the effects of incorrect synchronization	1

**Q22. (a)** A 100KVA, 3000V, 50Hz, 3-phase star connected synchronous generator has effective armature resistance of 0.2 ohm. The field current of 40 A produces short circuit current of 200A and an open circuit voltage of 1040 V (line value). Calculate the full-load voltage regulation at 0.8 p.f lagging and at 0.8 p.f leading using synchronous impedance method.

<b>Rubric</b>	<b>Marks</b>
Formula and synchronous impedance method	3
Correct calculations and final answer	2

**(OR)**

**(b)** Derive the EMF equation of a synchronous generator and explain the effect of distributed and short-pitched windings.

<b>Rubric</b>	<b>Marks</b>
EMF equation derivation of Synchronous generator	3
Effect of distributed and short- Pitched winding	2

### Section 6 (Answer all question(s))

**Marks CO BL**

**Q23.** Differentiate between asynchronous motor and synchronous motor.

2 1 1

<b>Rubric</b>	<b>Marks</b>
Key differences of synchronous and asynchronous motor	2

**Q24.** Define efficiency of synchronous motor. What are the different types of losses present in a synchronous motor? Explain in detail.

<b>Rubric</b>	<b>Marks</b>
Definition and formula of efficiency of synchronous motor	2
Explanation and any types of losses	1

**Q25. (a)** Why is a three-phase induction motor self-starting, but a three-phase synchronous motor is not? Explain in detail. Also, discuss the applications of a three-phase synchronous motor.

5 4 4

Rubric	Marks
Explanation of self-starting behavior of three phase synchronous motor.	3
Applications of three phase synchronous motor	2

**(OR)**

- (b)** What is V-curve and inverted V-curve of a synchronous motor? Explain, how does field excitation of a synchronous motor controls the reactive power supplied to or consumed by the power system.

Rubric	Marks
V-curve and inverted V-curve explanation of synchronous motor	3
Field excitation and reactive power control	2

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