# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

**Dundigal, Hyderabad-500043**

## ELECTRICAL AND ELECTRONICS ENGINEERING

## TUTORIAL QUESTION BANK

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| **Course Name** | : | ELECTRICAL MACHINES - II |
| **Course Code** | : | AEEB15 |
| **Program** | : | B.Tech |
| **Class** | : | B.Tech IV Semester |
| **Branch** | : | Electrical And Electronics Engineering |
| **Year** | : | 2019 – 2020 |
| **Course Coordinator** | : | Mr. K Devender Reddy, Assistant Professor |
| **Course Faculty** | : | Mr. K Devender Reddy, Assistant Professor<br>Mr. A Satish Kumar, Assistant Professor |

## I. COURSE OBJECTIVES:

**The course should enable the students to:**

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| I | Discuss the construction, working and characteristics of three phase induction motor and synchronous motor. |
| II | Illustrate the equivalent circuit and speed control methods of three phase induction motors. |
| III | Outline the working and parallel operation of alternators. |
| IV | Evaluate synchronous impedance and voltage regulation of synchronous machine. |

## COURSE OUTCOMES(COs):

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| **CO1** | Analyze constant, pulsating and revolving magnetic fields |
| **CO2** | Describe the operation and performance of three phase induction motors |
| **CO3** | Understand the operation and performance characteristics of synchronous generator |
| **CO4** | Demonstrate the construction and operation of synchronous motor |
| **CO5** | Understand the construction, starting methods and torque speed characteristics of various single phase induction motors |

## COURSE LEARNING OUTCOMES(CLOs):

**Students, who complete the course, will have demonstrated the ability to do the following:**

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| AEEB15.01 | Understand the concept of constant magnetic fields |
| AEEB15.02 | Analyze pulsating fields produced by spatially displaced windings |
| AEEB15.03 | Describe revolving magnetic fields |
| AEEB15.04 | Understand the principle of operation, constructional features different types of torques, various losses, efficiency and torque- slip characteristics of three phase induction motor |

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| AEEB15.05 | Describe no -load and blocked rotor test of three phase induction motor for calculating the equivalent circuit parameters and circle diagram |
| AEEB15.06 | Understand the starting and speed control methods of three phase induction motor, induction generator and doubly-fed Induction machines |
| AEEB15.07 | Understand the principle of operation and constructional features and different types of armature windings of synchronous alternator |
| AEEB15.08 | Understand the phasor diagrams of alternator on no-load, load and analyze the harmonics and its suppression methods. |
| AEEB15.09 | Describe the different methods for calculating the voltage regulation, parallel operation and slip test |
| AEEB15.10 | Understand the principle of operation, constructional features and starting methods of synchronous motor |
| AEEB15.11 | Describe the importance of power, excitation circles and effect of varying different parameters on synchronous motor performance |
| AEEB15.12 | Understand the concept of constructing V, inverted V curves and synchronous condenser |
| AEEB15.13 | Understand double revolving, cross field theory and the principle of operation and constructional features of single phase induction motor |
| AEEB15.14 | Describe the starting methods of single phase induction motor |
| AEEB15.15 | Describe the torque-speed characteristics of single phase induction motor and equivalent circuit. |
| AEEB15.16 | Apply the concept of electromagnetic and electrostatic fields to solve real time world applications. |
| AEEB15.17 | Explore the knowledge and skills of employability to succeed in national and international level competitive examinations. |

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| **MODULE – I** | | | | |
| **PULSATING AND REVOLVING MAGNETIC FIELDS** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| **S No** | **QUESTION** | **Blooms Taxonomy Level** | **Course Outcomes** | **Course Learning Outcomes (CLOs)** |
| 1 | What is pulsating magnetic field? | Understand | CO1 | AEEB15.02 |
| 2 | How rotating magnetic field is produced in the stator? | Understand | CO1 | AEEB15.03 |
| 3 | What is the speed of rotating magnetic field? | Remember | CO1 | AEEB15.03 |
| 4 | What happens if you spin a magnet? | Understand | CO1 | AEEB15.03 |
| 5 | How does the rotor become magnetic? | Understand | CO1 | AEEB15.02 |
| 6 | How can you make a magnet | Remember | CO1 | AEEB15.01 |
| 7 | How do you demagnetize a magnet? | Remember | CO1 | AEEB15.01 |
| 8 | Which grades of stainless steel are magnetic? | Remember | CO1 | AEEB15.01 |
| 9 | What is the name of a magnet made from a coil of wire? | Understand | CO1 | AEEB15.02 |
| 10 | Why steel is not used for making electromagnet? | Remember | CO1 | AEEB15.02 |
| 11 | What is the best metal for an electromagnet? | Remember | CO1 | AEEB15.02 |
| 12 | Which material is used for electromagnet? | Understand | CO1 | AEEB15.02 |
| 13 | Who discovered electromagnetism? | Remember | CO1 | AEEB15.02 |
| 14 | What are the different types of electromagnets? | Understand | CO1 | AEEB15.02 |
| 15 | What causes a magnetic field? | Remember | CO1 | AEEB15.01 |
| 16 | What is magnetic field strength? | Remember | CO1 | AEEB15.01 |
| 17 | Why do magnetic field lines move from north to south? | Remember | CO1 | AEEB15.01 |
| 18 | What is magnetism in simple terms? | Remember | CO1 | AEEB15.01 |
| 19 | Does the South Pole have a magnetic pull? | Remember | CO1 | AEEB15.01 |
| 20 | Which is the strongest magnetic material? | Remember | CO1 | AEEB15.01 |
| **PART - B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Demonstrate constant magnetic field | Understand | CO1 | AEEB15.01 |
| 2 | Describe the pulsating magnetic field | Remember | CO1 | AEEB15.02 |
| 3 | Explain the operation of magnetic field produced in windings by alternating current | Understand | CO1 | AEEB15.02 |

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| 4 | Demonstrate the magnetic field produced by spatial displacement of windings | Understand | CO1 | AEEB15.02 |
| 5 | Describe the process of magnetic field produced by single winding | Understand | CO1 | AEEB15.02 |
| 6 | Demonstrate the process of magnetic field produced by fixed current | Remember | CO1 | AEEB15.02 |
| 7 | Demonstrate the process of magnetic field produced by alternating current | Remember | CO1 | AEEB15.02 |
| 8 | Explain the process of pulsating magnetic fields produced by spatial displaced windings | Understand | CO1 | AEEB15.02 |
| 9 | Explain the process of pulsating magnetic fields produced by spatially shifted by 90 degrees windings | Understand | CO1 | AEEB15.02 |
| 10 | Explain the process of addition of pulsating magnetic fields | Understand | CO1 | AEEB15.02 |
| 11 | Demonstrate the process of magnetic field produced by three windings spatially shifted by 120 degrees | Understand | CO1 | AEEB15.02 |
| 12 | Explain the process of production of rotating magnetic field | Understand | CO1 | AEEB15.03 |
| 13 | Derive the mathematical proof for rotating magnetic field | Remember | CO1 | AEEB15.03 |
| 14 | Compare pulsating and rotating magnetic fields | Remember | CO1 | AEEB15.03 |
| 15 | Compare constant and pulsating magnetic fields | Understand | CO1 | AEEB15.01 |
| 16 | Explain amperes force law | Understand | CO1 | AEEB15.01 |
| 17 | Explain faradays laws of electromagnetic induction | Understand | CO1 | AEEB15.01 |
| 18 | Demonstrate Flemings right hand rule | Understand | CO1 | AEEB15.01 |
| 19 | Demonstrate Flemings left hand rule | Understand | CO1 | AEEB15.01 |
| 20 | Demonstrate lenzs law | Understand | CO1 | AEEB15.01 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | A cage induction motor when started by means of a star-Delta starter takes 160 % of full load current & develops 25 % of full load torque at starting. Calculate the starting current & torque in terms of full load torque when started by means of an auto transformer with 65% tapping. | Understand | CO1 | AEEB15.02 |
| 2 | A 3-phase, 400V induction motor has the following test readings: - No-load:- 300V, 1250W, 9 A Short circuit:- 160V, 4KW,38 A Draw the circle diagram. If the normal rating is 14.9 KW, find from the circle diagram, the full load value of current, power factor and slip. | Understand | CO1 | AEEB15.02 |
| 3 | A 4 pole, 50 Hz, wound rotor IM has a rotor resistance of 0.53 ph and runs at 1420 rpm at full load. Calculate the additional resistance per phase to be inserted in the rotor circuit to lower the speed to 1180 rpm, if the torque remains constant. | Understand | CO1 | AEEB15.02 |
| 4 | Two 50HZ, 3 phase induction motors having six and four poles respectively are cumulatively cascaded, the 6 pole motor being connected to the main supply. Determine the frequencies of the rotor currents and the slips refereed to each stator field if the set has a slip of 5%. | Understand | CO1 | AEEB15.02 |

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| 5 | A 3 phase, 6 pole 50Hz induction motor when fully loaded, runs with a slip of 6%. Find the value of resistance necessary in series per phase of the rotor to reduce the speed by 15%. Assume that the resistance of the rotor per phase is 0.30 ohm. | Understand | CO1 | AEEB15.02 |
| 6 | Two slip ring IMs having 12 & 8 poles respectively are mechanically coupled.<br>i. Calculate the possible speed when first motor is supplied from a 50 Hz supply line.<br>ii. Calculate the ratio of power shared by the two motors.<br>iii. If the smallest possible speed is to be attained independently by each machine, calculate the frequency of the voltage to be injected in the rotor circuit | Understand | CO1 | AEEB15.03 |
| 7 | A 6 pole, 50 Hz, 3 phase induction motor is running at 3 percent slip when delivering full load torque. It has standstill rotor resistance of 0.33 ohm and reactance of 0.53 ohm per phase. Calculate the speed of the motor if an additional resistance of 0.72 ohm per phase is inserted in the rotor circuit. The full load torque remains constant | Understand | CO1 | AEEB15.03 |
| 8 | Two 50 Hz, 3 phase Induction motors having six and four poles respectively are cumulatively cascaded, the 6 pole motor being connected to the main supply. Determine the frequency of the rotor currents and the slips referred to each stator field if the set has a slip of 8%. | Understand | CO1 | AEEB15.03 |
| 9 | A 50 KVA, 400V, 3 phase, 50 Hz squirrel cage Induction motor has full load slip of 10%. Its standstill impedance is 0.866 ohms per phase. It is started using a tapped auto transformer. If the maximum allowable supply current at the time of starting is 120A, calculate the tap position and the ratio of starting torque to full load. | Understand | CO1 | AEEB15.03 |
| 10 | A three-phase delta-connected cage type induction, motor when connected directly to a 400 V, 50Hz supply, takes a starting current of 110 A, in each stator phase. Calculate<br>i) The line current for `direct--on-line' starting.<br>ii) Line and phase starting currents for star-delta starting | Understand | CO1 | AEEB15.03 |
| 11 | A cage induction motor when started by means of a star-Delta starter takes 195 % of full load current & develops 55 % of full load torque at starting. Calculate the starting current & torque in terms of full load torque when started by means of an auto transformer with 85% tapping. | Understand | CO1 | AEEB15.01 |
| 12 | A 3-phase, 400V induction motor has the following test readings: - No-load:- 400V, 1350 W, 12 A Short circuit:- 150 V, 3.5 KW, 42 A Draw the circle diagram. If the normal rating is 15.9 KW, find from the circle diagram, the full load value of current, power factor and slip. | Understand | CO1 | AEEB15.01 |

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| 13 | A 4 pole, 50 Hz, wound rotor IM has a rotor resistance of 0.59 ph and runs at 1440 rpm at full load. Calculate the additional resistance per phase to be inserted in the rotor circuit to lower the speed to 1250 rpm, if the torque remains constant. | Understand | CO1 | AEEB15.01 |
| 14 | Two 50HZ, 3-phase induction motors having six and four poles respectively are cumulatively cascaded, the 6 pole motor being connected to the main supply. Determine the frequencies of the rotor currents and the slips refereed to each stator field if the set has a slip of 3 %. | Understand | CO1 | AEEB15.01 |
| 15 | A 3 phase, 6 pole 50Hz induction motor when fully loaded, runs with a slip of 4%. Find the value of resistance necessary in series per phase of the rotor to reduce the speed by 12%. Assume that the resistance of the rotor per phase is 0.25 ohm. | Understand | CO1 | AEEB15.01 |
| **MODULE – II** | | | | |
| **INDUCTION MACHINES** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | Explain the principle of induction motor | Understand | CO2 | AEEB15.04 |
| 2 | What are the types of induction motors? | Remember | CO2 | AEEB15.04 |
| 3 | What are the main parts of three-phase induction motor? | Remember | CO2 | AEEB15.04 |
| 4 | Discuss the importance of slip in an induction motor | Understand | CO2 | AEEB15.04 |
| 5 | Explain the power flow diagram of three phase induction motor? | Understand | CO2 | AEEB15.04 |
| 6 | What are the advantages of auto transformer starting? | Understand | CO2 | AEEB15.06 |
| 7 | What are the advantages of slip ring induction motor over squirrel cage induction motor? | Understand | CO2 | AEEB15.04 |
| 8 | What is meant by cascade operation? | Understand | CO2 | AEEB15.04 |
| 9 | Discuss about direct online starting of an induction motor? | Understand | CO2 | AEEB15.06 |
| 10 | What are the applications of induction generators? | Remember | CO2 | AEEB15.06 |
| 11 | Compare squirrel cage induction motor with slip-ring induction motor | Understand | CO2 | AEEB15.04 |
| 12 | What are the applications of squirrel cage induction motor with slip-ring induction motor? | Understand | CO2 | AEEB15.04 |
| 13 | Compare starting methods of induction motor. | Remember | CO2 | AEEB15.06 |
| 14 | Describe double squirrel cage rotor. | Understand | CO2 | AEEB15.06 |
| 15 | Write short notes on torque-slip characteristics of three phase induction motor? | Understand | CO2 | AEEB15.05 |
| 16 | Explain the effect of rotor resistance on torque of induction motor? | Understand | CO2 | AEEB15.04 |
| 17 | Explain crawling effect in three phase induction motor | Remember | CO2 | AEEB15.05 |
| 18 | Explain cogging effect in three phase induction motor | Remember | CO2 | AEEB15.04 |

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| 19 | Write short notes on torque-speed characteristics of three phase induction motor? | Remember | CO2 | AEEB15.04 |
| 20 | Derive the expression for torque on full load condition | Remember | CO2 | AEEB15.04 |
| **PART - B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Describe the principle operation and constructional features of three phase induction motor. | Understand | CO2 | AEEB15.04 |
| 2 | Discuss the various losses taking place in induction motor and explain the effect of slip on the Performance of induction machine. | Understand | CO2 | AEEB15.04 |
| 3 | Derive the torque equation of an induction motor. Mention the condition for maximum torque. | Remember | CO2 | AEEB15.04 |
| 4 | Describe the constructional features of both slip ring and squirrel cage induction motor. Discuss the merits of one over the other. | Understand | CO2 | AEEB15.04 |
| 5 | With neat diagram describe the equivalent circuit of three phase double cage induction motor. | Understand | CO2 | AEEB15.06 |
| 6 | Draw and explain the phasor diagram of an induction motor | Understand | CO2 | AEEB15.04 |
| 7 | Derive the expression for rotor power output | Remember | CO2 | AEEB15.04 |
| 8 | With neat diagram discuss the various tests to be conducted on three phase induction motor to plot the circle diagram. | Understand | CO2 | AEEB15.05 |
| 9 | Compare DOL starter, Auto transformer starter & Rotor resistance starter with relate to the following:<br>(i) Starting current<br>(ii) Starting torque | Understand | CO2 | AEEB15.06 |
| 10 | Derive the condition for maximum torque of the induction motor under running condition. | Understand | CO2 | AEEB15.04 |
| 11 | Describe the speed control of induction motor by rotor resistance control method. How this method of speed control is different from stator side speed control methods. | Understand | CO2 | AEEB15.06 |
| 12 | Compare the speed control of 3phase IM by rotor resistance control & variable frequency control. | Understand | CO2 | AEEB15.06 |
| 13 | Explain the terms air gap power; internal mechanical power developed and shaft power. How these terms related with each other. Hence show that:<br>Pg: rotor ohmic loss: Pm = 1:S:(1-S) | Remember | CO2 | AEEB15.04 |
| 14 | With the help of experimental circuit, describe how the equivalent circuit parameters are determined by no load and blocked rotor tests on three phase Induction motor. | Understand | CO2 | AEEB15.05 |
| 15 | With the help of a neat diagram, describe the working of a star - delta starter. | Understand | CO2 | AEEB15.06 |
| 16 | Discuss the working principle of Induction generator. | Understand | CO2 | AEEB15.06 |
| 17 | Mention the advantages and disadvantages of induction generator. | Remember | CO2 | AEEB15.06 |
| 18 | Draw and explain the equivalent circuit and phasor diagram for three phase induction motor | | CO2 | AEEB15.08 |
| 19 | Explain the performance curves of three phase induction motor | | CO2 | AEEB15.05 |
| 20 | Discuss the advantages, disadvantages and applications of induction motors | | CO2 | AEEB15.04 |

| PART - C (ANALYTICAL QUESTIONS) | | | | |
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| 1 | The frequency of stator EMF is 50 Hz for an 8-pole three phase induction motor. If the rotor frequency is 2.5 Hz, calculate the slip and the actual speed of rotor. | Understand | CO2 | AEEB15.04 |
| 2 | An 8 pole, three phase alternator is coupled to a prime mover running at 750 rpm. It supplies an induction motor which has a full load speed of 960 rpm. Find the number of poles of induction motor and slip. | Understand | CO2 | AEEB15.04 |
| 3 | In case of an 8-pole three phase induction motor the supply frequency is 50 Hz and the shaft speed is 735 rpm. Compute (i) Synchronous speed (ii) Slip speed per unit slip (iii) Percentage slip. | Understand | CO2 | AEEB15.04 |
| 4 | A three phase induction motor is wound for 4 poles and is supplied from 50Hz system. Calculate i) Synchronous speed ii) Rotor speed, when slip is 4% iii) Rotor frequency when rotor runs at 60 rpm. | Understand | CO2 | AEEB15.04 |
| 5 | An 8-pole, 50 Hz, 3 phase slip ring induction motor has effective resistance of 0.08 /phase The speed corresponding to maximum torque is 650 rpm. What is the value of resistance to be inserted in rotor circuit to obtain maximum torque at starting? | Understand | CO2 | AEEB15.04 |
| 6 | A 4 pole, 400 V, 3phase induction motro has a standstill rotor EMF of 100 V per phase. The rotor has resistance of 50 Ώ/ph and standstill reactance of 0.5 Ώ/ph. Calculate the maximum torque & slip at which it occurs. Neglect stator impedance. | Understand | CO2 | AEEB15.04 |
| 7 | The power input to a 500V, 50Hz, 6-pole, three phase induction motor running at 975 rpm is 40 KW. The stator losses are 1KW and the friction and wind age losses total to 2KW, Calculate i) The slip ii) Rotor copper loss iii) Shaft power. | Understand | CO2 | AEEB15.04 |
| 8 | An 8 pole, three phase alternator is coupled to an engine running at 750 rpm. The alternator supplies power to an induction motor which has a full load speed of 1425 rpm. Find the percentage slip and the number of poles of the motor | Understand | CO2 | AEEB15.04 |
| 9 | A cage induction motor when started by means of a star-Delta starter takes 180 % of full load current & develops 35 % of full load torque at starting. Calculate the starting current & torque in terms of full load torque when started by means of an auto transformer with 75% tapping. | Understand | CO2 | AEEB15.06 |
| 10 | A 3-phase, 400V induction motor has the following test readings: - No-load:- 400V, 1250W, 9 A Short circuit: - 150V, 4KW,38 A Draw the circle diagram. If the normal rating is 14.9 KW, find from the circle diagram, the full load value of current, power factor and slip. | Understand | CO2 | AEEB15.05 |
| 11 | A 4 pole, 50 Hz, wound rotor IM has a rotor resistance of 0.56 ph and runs at 1430 rpm at full load. Calculate the additional resistance per phase to be inserted in the rotor circuit to lower the speed to 1200 rpm, if the torque remains constant. | Understand | CO2 | AEEB15.06 |

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| 12 | Two 50HZ, 3 phase induction motors having six and four poles respectively are cumulatively cascaded, the 6 pole motor being connected to the main supply. Determine the frequencies of the rotor currents and the slips refereed to each stator field if the set has a slip of 2%. | Understand | CO2 | AEEB15.04 |
| 13 | A 3 phase, 6 pole 50Hz induction motor when fully loaded, runs with a slip of 3%. Find the value of resistance necessary in series per phase of the rotor to reduce the speed by 10%. Assume that the resistance of the rotor per phase is 0.2 Ω | Understand | CO2 | AEEB15.05 |
| 14 | Two slip ring induction motor having 10 & 6 poles respectively are mechanically coupled.<br>i. Calculate the possible speed when first motor is supplied from a 50 Hz supply line.<br>ii. Calculate the ratio of power shared by the two motors.<br>iii. If the smallest possible speed is to be attained independently by each machine, calculate the frequency of the voltage to be injected in the rotor circuit | Understand | CO2 | AEEB15.06 |
| 15 | A 6 pole, 50 Hz, 3 phase induction motor is running at 3 percent slip when delivering full load torque. It has standstill rotor resistance of 0.2 ohm and reactance of 0.4 ohm per phase. Calculate the speed of the motor if an additional resistance of 0.6 ohm per phase is inserted in the rotor circuit. The full load torque remains constant | Understand | CO2 | AEEB15.06 |
| 16 | Two 50 Hz, 3 phase Induction motors having six and four poles respectively are cumulatively cascaded, the 6 pole motor being connected to the main supply. Determine the frequency of the rotor currents and the slips referred to each stator field if the set has a slip of 2%. | Understand | CO2 | AEEB15.06 |
| 17 | A 50 KVA, 400V, 3 phase, 50 Hz squirrel cage Induction motor has full load slip of 5%. Its standstill impedance is 0.866 ohms per phase. It is started using a tapped auto transformer. If the maximum allowable supply current at the time of starting is 100A, calculate the tap position and the ratio of starting torque to full load. | Understand | CO2 | AEEB15.06 |
| 18 | A three-phase delta-connected cage type induction, motor when connected directly to a 400 V, 50Hz supply, takes a starting current of 100 A, in each stator phase. Calculate<br>i) The line current for `direct--on-line' starting.<br>ii) Line and phase starting currents for star-delta starting | Understand | CO2 | AEEB15.06 |
| **MODULE-III** | | | | |
| **ALTERNATORS** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | State different type of synchronous generators used in hydro electrical power station. | Remember | CO3 | AEEB15.07 |

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| 2 | What are the main parts of synchronous generator? | Remember | CO3 | AEEB15.07 |
| 3 | Derive the EMF equation of an Alternator. | Understand | CO3 | AEEB15.07 |
| 4 | What is the speed of a 4 pole 50Hz Synchronous machine? | Understand | CO3 | AEEB15.07 |
| 5 | Define Synchronous speed. | Understand | CO3 | AEEB15.07 |
| 6 | How can a DC generator be converted into an alternator? | Understand | CO3 | AEEB15.07 |
| 7 | Discuss about armature reaction in synchronous generator. | Understand | CO3 | AEEB15.07 |
| 8 | Define distribution factor. | Understand | CO3 | AEEB15.07 |
| 9 | Define pitch factor. | Understand | CO3 | AEEB15.07 |
| 10 | Define winding factor. | Understand | CO3 | AEEB15.07 |
| 11 | Define the following<br>a) Short pitch winding<br>b) Full pitch winding | Understand | CO3 | AEEB15.07 |
| 12 | Define the following<br>a) Concentrated winding<br>b) Distributed winding | Understand | CO3 | AEEB15.07 |
| 13 | Define the following<br>a) Single layer winding<br>b) Double layer winding | Understand | CO3 | AEEB15.07 |
| 14 | Explain effect of changing the power factor on terminal voltage by keeping the Load current, Field current and Speed constant | Understand | CO3 | AEEB15.07 |
| 15 | Draw the equivalent circuit for three phase alternator. | Remember | CO3 | AEEB15.07 |
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| 15 | Define voltage regulation of alternator. | Remember | CO3 | AEEB15.09 |
| 16 | Discuss the advantages and disadvantages of EMF method. | Remember | CO3 | AEEB15.09 |
| 17 | Discuss the advantages and disadvantages of MMF method. | Understand | CO3 | AEEB15.09 |
| 18 | Discuss the advantages and disadvantages of ZPF method. | Understand | CO3 | AEEB15.09 |
| 19 | Explain about $X_d$ and $X_q$ of salient pole synchronous generator. | Understand | CO3 | AEEB15.09 |
| 20 | What are the advantages of parallel operation? | Understand | CO3 | AEEB15.09 |
| 21 | What are the conditions for parallel operation? | Understand | CO3 | AEEB15.09 |
| **PART – B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Explain the working principle and derive EMF equation of an alternator. | Understand | CO3 | AEEB15.07 |
| 2 | Discuss the procedure for determination of synchronous reactance of an alternator. | Remember | CO3 | AEEB15.07 |
| 3 | Draw the load characteristics of synchronous generator and describe the same. | Understand | CO3 | AEEB15.07 |
| 4 | Compare integral slot and fractional slot windings | Remember | CO3 | AEEB15.07 |
| 5 | With phasor diagram, discuss about the leakage reactance of synchronous generator | Remember | CO3 | AEEB15.08 |

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| 6 | Compute the distribution factor for a 36-slot, 4-pole, single-layer 3-Phase winding. | Understand | CO3 | AEEB15.07 |
| 7 | Explain slot and space harmonics in alternator. | Understand | CO3 | AEEB15.08 |
| 8 | Derive EMF equation and describe how the induced EMF in armature winding is affected by (a) form factor (b) pitch factor and (c) distribution factor | Understand | CO3 | AEEB15.07 |
| 9 | Explain the alternator on load for different power factors with phasor diagrams. | Understand | CO3 | AEEB15.07 |
| 10 | Explain the harmonic suppression techniques. | Understand | CO3 | AEEB15.08 |
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| 11 | Discuss in brief, how the voltage regulation can be computed by synchronous impedance method. | Understand | CO3 | AEEB15.09 |
| 12 | Discuss in brief about the two-reaction analysis of a salient-pole synchronous machine. | Understand | CO3 | AEEB15.09 |
| 13 | With relevant waveforms and connection diagram, describe the slip test of synchronous machine. | Understand | CO3 | AEEB15.09 |
| 14 | Discuss in brief, how voltage regulation can be computed by MMF method. | Remember | CO3 | AEEB15.09 |
| 15 | Discuss in brief, how voltage regulation can be computed by ASA method. | Remember | CO3 | AEEB15.09 |
| 16 | Discuss in brief, how voltage regulation can be computed by EMF method. | Remember | CO3 | AEEB15.09 |
| 17 | Discuss in brief, how voltage regulation can be computed by ZPF method. | Remember | CO3 | AEEB15.09 |
| 18 | Explain the conditions and necessity for parallel operation of alternators | Remember | CO3 | AEEB15.09 |
| 19 | Explain the following methods<br>i) Three dark lamp method<br>ii) Two bright and one dark lamp method | Understand | CO3 | AEEB15.09 |
| 20 | Discuss the effect of reactance and excitation on parallel operation | Understand | CO3 | AEEB15.09 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | Calculate the speed and open-circuit line and phase voltages of a 4-pole, 3-phase, 50hz star-connected alternator with 36 slots and 30 slots 30 conductors per slot. The flux per pole is 0.05wb. | Understand | CO3 | AEEB15.07 |
| 2 | A 4-ploe, 50hz star-connected alternator has a flux per pole of 0.12wb. It has 4 slots per pole per phase, conductors per slot being 4.if the winding coil span is $150^0$, find the EMF. | Understand | CO3 | AEEB15.07 |
| 3 | A 3-phase, 8-pole, 750 rpm star-connected alternator has 72 slots on the armature. Each slot has 12 conductors and winding is short-pitched by 2 slots. Find the induced EMF between lines, given the flux per pole is 0.06wb | Understand | CO3 | AEEB15.07 |
| 4 | An 8-pole, 3-phase, $60^0$ spread, double layer winding has 72 coils in 72 slots. The coils are short-pitched by two slots. Calculate the winding factor for the fundamental and third harmonic. | Understand | CO3 | AEEB15.07 |

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| 5 | The stator of a 3-phase, 20-pole alternator has 120 slots and there are 4 conductors per slot accommodated in two layers. If the speed of the alternator is 300rpm, calculate the EMF induced per phase. Resultant flux in the air-gap is 0.05 wb per pole. Assume the coil span as $160^0$ electrical. | Understand | CO3 | AEEB15.07 |
| 6 | A star-connected, 3-phase, 6-pole alternator has a stator with 90 slots and 8 conductors per slot. The rotor revolves at 1000rpm. The flux per pole is $4x10^{-2}$ wb. Calculate the EMF generated if all the conductors in each phase are in series. Assume sinusoidal flux distribution and full-pitched coils. | Understand | CO3 | AEEB15.07 |
| 7 | A 16 pole, 3-phase alternator has a star-connected winding with 144 slots and 10 conductors per slot. The flux per pole is 0.03wb distributed sinusoidal and the speed is 375 rpm. Find the line voltage, if the coil span is $150^0$ elec. | Understand | CO3 | AEEB15.07 |
| 8 | A 3-phase, 16-pole alternator has the following data: number of slots=192, conductors per slot=8, coil span 10 slots; speed of alternator=375rpm; flux per pole =55mwb.calculate the phase and line voltage. | Understand | CO3 | AEEB15.07 |
| 9 | For a 3phase winding with 4 slots per pole phase and with the coin span of 10 slot pitch, calculate the values of the distribution factor and coil span factor. | Understand | CO3 | AEEB15.07 |
| 10 | An 8-pole ac generator is running at 750rpm. What is the frequency? At what speed must the generator be run so that frequency shall be 25hz? | Understand | CO3 | AEEB15.07 |
| 11 | A 6-ploe, 50hz star-connected alternator has a flux per pole of 0.15wb. It has 6 slots per pole per phase, conductors per slot being 4.if the winding coil span is $150^0$, find the EMF. | Understand | CO3 | AEEB15.07 |
| 12 | The stator of a 3-phase, 24-pole alternator has 120 slots and there are 4 conductors per slot accommodated in two layers. If the speed of the alternator is 500rpm, calculate the EMF induced per phase. Resultant flux in the air-gap is 0.06 wb per pole. Assume the coil span as $140^0$ electrical. | Understand | CO3 | AEEB15.07 |
| 13 | A star-connected, 3-phase, 6-pole alternator has a stator with 90 slots and 6 conductors per slot. The rotor revolves at 1200rpm. The flux per pole is $4x10^{-3}$ wb. Calculate the EMF generated if all the conductors in each phase are in series. Assume sinusoidal flux distribution and full-pitched coils. | Understand | CO3 | AEEB15.07 |
| 14 | A 16 pole, 3-phase alternator has a star-connected winding with 144 slots and 8 conductors per slot. The flux per pole is 0.03wb distributed sinusoidal and the speed is 500 rpm. Find the line voltage, if the coil span is $145^0$ elec. | Understand | CO3 | AEEB15.07 |
| 15 | A 3-phase, 16-pole alternator has the following data: number of slots=192, conductors per slot=6, coil span 10 slots; speed of alternator=475rpm; flux per pole =45mwb.calculate the phase and line voltage. | Understand | CO3 | AEEB15.07 |
| | | | | |
| 16 | A 3-phase star-connected synchronous generator is rated at 1.4MVA, 11KV. The armature effective resistance and synchronous reactance are 1.2 Ω and 25Ω respectively per phase. Calculate the percentage voltage regulation for a load of 1.4375MVA at (i) 0.8pf lagging and (ii) 0.8 p.f leading. Also find out the p.f at which the regulation becomes zero. | Understand | CO3 | AEEB15.09 |

<table>
<tr><td>17</td><td>A 3-phase, star-connected alternator is rated at 1600kva, 13500v. The armature resistance and synchronous reactance are 1.5 Ω and 30Ω respectively per phase. Calculate the percentage regulation for a load of 1280kw at 0.8leading power factor.</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>18</td><td>From the following test results, determine the regulation of a 2 KV single phase alternator, delivering a current of 100 A at 0.8 p.f. leading test results; full load current of 100 A is produced on short circuit by a field excitation of 2.5 A. An EMF of 500 V is produced on open circuit by the same field current. The armature resistance is 0.8 ohms.</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>19</td><td>A three phase star connected 1000 KVA, 11000 V alternator has rated current of 52.5 A the ac resistance of the winding per phase is 0.45 Ohms. The test results are given below; OC test : field current = 12.5 A, voltage between lines = 422 V. SC test: field current = 12.5 A , line current = 52.5 A determine the full load voltage regulation of the alternator a) 0.8 p.f. lagging b) 0.8 p.f. leading</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>20</td><td>I) A three phase star connected, 5KVA, 400 V, 50 Hz, 4-pole alternator has the following test data at rated speed
<table>
<tr><td>$I_f$</td><td>$V_{oc\ ph}$</td><td>Exciting current</td><td>Short circuit line current</td></tr>
<tr><td>0.5</td><td>75</td><td>1</td><td>3.6</td></tr>
<tr><td>1</td><td>140</td><td>2</td><td>7.2</td></tr>
<tr><td>1.5</td><td>173</td><td>3</td><td>10.8</td></tr>
<tr><td>2</td><td>202</td><td></td><td></td></tr>
<tr><td>2.5</td><td>224</td><td></td><td></td></tr>
<tr><td>3</td><td>238</td><td></td><td></td></tr>
<tr><td>3.5</td><td>250</td><td></td><td></td></tr>
<tr><td>4</td><td>257</td><td></td><td></td></tr>
<tr><td>4.5</td><td>260</td><td></td><td></td></tr>
<tr><td>5</td><td>263</td><td></td><td></td></tr>
<tr><td>6</td><td>266</td><td></td><td></td></tr>
<tr><td>8</td><td>271</td><td></td><td></td></tr>
</table>
Armature resistance per phase is 2 ohms<br>Draw OC and SC characteristics on a graph paper and then determine unsaturated value of synchronous reactance per phase and in per unit.<br>II) For the same synchronous machine, a) determine percentage voltage regulation at rated load at 0.8 p.f. lag and lead by synchronous impedance method under unsaturated condition. Draw relevant phasor diagrams.</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>21</td><td>A 3-phase star-connected, 1000kva, 2000v, 50hz alternator gave the following open-circuit and short circuit test readings:
<table>
<tr><td>Field current(Amp)</td><td>Open-circuit voltage(V)</td><td>Short-circuit current(Amp)</td></tr>
<tr><td>10</td><td>800</td><td>200</td></tr>
<tr><td>20</td><td>1500</td><td>250</td></tr>
<tr><td>25</td><td>1760</td><td>300</td></tr>
<tr><td>30</td><td>2000</td><td>-</td></tr>
<tr><td>40</td><td>2350</td><td>-</td></tr>
<tr><td>50</td><td>2600</td><td>-</td></tr>
</table>
Draw the characteristic curves and estimate the full-load percentage regulation at i) 0.8 p.f. lagging and (ii) 0.8 p.f. leading. the armature resistance per phase may be taken as 0.2Ω.use MMF method</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
</table>

<table>
<tr><td>22</td><td>A 3.5 MVA, slow speed, 3-phase synchronous generator rated at 6.6kv has 62 poles. It's direct and quadrature axis synchronous reactance as measured by the slip test is 9.6 and 6 Ω respectively. Neglect armature resistance; determine the regulation and excitation EMF needed to maintain 6.6kv at the terminals when supplying a load of 2.5MW at 0.8pf lagging. What maximum power can generator supply at the rated terminal voltage, if the field becomes open-circuited?</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>23</td><td>A 10kva, 380v, 50hz, 3-phase, star-connected salient pole alternator has direct axis and quadrature axis reactance of 12Ω and 8Ω respectively. The armature has a resistance of 1Ω per phase. The generator delivers rated load at 0.8pf lagging with the terminal voltage being maintained at rated value. If the load angle is $16.15^0$, determine (i) the direct axis and quadrature axis components of armature current (ii) exciting voltage of the generator.</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>24</td><td>The following data pertains to a 15000 kva,11kv,3-phase,50hz,star-connected turbo-alternator:
<table>
<tr><td>Voc line (KV)</td><td>Field AT in $10^3$</td><td>ZPF full load line KV</td></tr>
<tr><td>4.9</td><td>10</td><td>-</td></tr>
<tr><td>8.4</td><td>18</td><td>0</td></tr>
<tr><td>10.1</td><td>24</td><td>-</td></tr>
<tr><td>11.5</td><td>30</td><td>-</td></tr>
<tr><td>12.8</td><td>40</td><td>-</td></tr>
<tr><td>13.3</td><td>45</td><td>102</td></tr>
<tr><td>13.65</td><td>50</td><td>-</td></tr>
</table>
Determine: (i) armature reaction (ii) armature reactance (iii) synchronous reactance (iv) percentage regulation for full-load at 0.8 p.f. lagging.</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>25</td><td>A three phase star connected 1200 KVA, 12000 V alternator has rated current of 52.5 A the ac resistance of the winding per phase is 0.45 Ohms. The test results are given below; OC test : field current = 12.56 A, voltage between lines = 532 V. SC test: field current = 12.56 A , line current = 52.55 A determine the full load voltage regulation of the alternator a) 0.8 p.f. lagging b) 0.8 p.f. leading</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>26</td><td>Two identical 2MVA alternators operate in parallel. The governor of first machine is such that the frequency droops uniformly from 50hz on no-load to 47.5 Hz on full-load.the corresponding uniform speed droop of the second machine is 50hz to 48hz. How will they share a load of 3MW?</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
<tr><td>27</td><td>Two identical 3-phase alternators work in parallel and supply a total load of 1600kw at 11000v at a power factor of 0.92. Each machine supplies half the total power. The synchronous reactance of each is 50 ohm per phase and resistance is 2.5 ohm per phase. The field excitation of the first machine is adjusted so that armature current is 50A lagging. Determine the armature current of the second alternator, the power factor at which each is working and generated voltage of the first alternator?</td><td>Understand</td><td>CO3</td><td>AEEB15.09</td></tr>
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| 28 | A 2000KVA, 3-phase,8-pole alternator runs at 750rpm in parallel with other machines on 6000v bus-bars. Find synchronizing power on full load 0.8 pf lagging per mechanical degree of displacement and the corresponding synchronizing torque. The synchronous reactance is 6 ohms per phase. | Understand | CO3 | AEEB15.09 |
| 29 | A 3000KVA, 3-phase, 8-pole alternator runs at 850rpm in parallel with other machines on 8000v bus-bars. Find synchronizing power on full load 0.86 pf lagging per mechanical degree of displacement and the corresponding synchronizing torque. The synchronous reactance is 8 ohms per phase. | Understand | CO3 | AEEB15.09 |
| 30 | Two identical 2 MVA alternators operate in parallel. The governor of first machine is such that the frequency drops uniformly from 50 Hz on no-load to 47.5 Hz on full-load. The corresponding uniform speed drop of the second machine is 50 Hz to 48 Hz. How will they share a load of 4 MW? | Understand | CO3 | AEEB15.09 |
| **MODULE - IV** | | | | |
| **SYNCHRONOUS MOTORS** | | | | |
| **PART – A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | What are the main parts of synchronous motor? | Remember | CO4 | AEEB15.10 |
| 2 | Discuss why synchronous motor has no starting torque | Understand | CO4 | AEEB15.10 |
| 3 | What are the uses of damper windings in a synchronous motor? | Understand | CO4 | AEEB15.10 |
| 4 | Why synchronous motor always runs at synchronous speed? | Remember | CO4 | AEEB15.10 |
| 5 | What is hunting? | Remember | CO4 | AEEB15.10 |
| 6 | What are the different methods of starting synchronous motor? | Remember | CO4 | AEEB15.10 |
| 7 | Why Synchronous motors are not self starting? | Understand | CO4 | AEEB15.10 |
| 8 | What is a synchronous condenser? What is the use of synchronous condenser? | Understand | CO4 | AEEB15.12 |
| 9 | What are the applications of synchronous motor? | Understand | CO4 | AEEB15.10 |
| 10 | Explain the suppression methods of hunting in synchronous motor | Understand | CO4 | AEEB15.10 |
| 11 | Define pull- in torque | Remember | CO4 | AEEB15.10 |
| 12 | Define pull- out torque | Remember | CO4 | AEEB15.10 |
| 13 | Define starting torque | Remember | CO4 | AEEB15.10 |
| 14 | Draw the power flow diagram of synchronous motor | Understand | CO4 | AEEB15.10 |
| 15 | List the types of torques in synchronous motor | Understand | CO4 | AEEB15.10 |
| 16 | Explain the importance of exciter for synchronous motor | Understand | CO4 | AEEB15.10 |
| 17 | How the synchronous motor is used as a synchronous condenser | Remember | CO4 | AEEB15.10 |
| 18 | Why synchronous motors are not self starting | Understand | CO4 | AEEB15.10 |
| 19 | What are the advantages of synchronous motor | Remember | CO4 | AEEB15.10 |

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| 20 | Compare synchronous motor with three phase induction motor | Understand | CO4 | AEEB15.10 |
| **PART – B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Describe the principle of operation of synchronous motor | Understand | CO4 | AEEB15.10 |
| 2 | Draw and discuss the phasor diagrams of a three phase synchronous motor for lagging, leading and unity power factor conditions | Understand | CO4 | AEEB15.10 |
| 3 | Explain constant power circle for synchronous motor? | Remember | CO4 | AEEB15.11 |
| 4 | Explain different methods of starting a synchronous motor. | Remember | CO4 | AEEB15.10 |
| 5 | Derive an expression of mechanical power developed for a synchronous motor in terms of E & V. | Understand | CO4 | AEEB15.10 |
| 6 | Mention the various applications of synchronous motor and describe the functions of a damper winding in a synchronous motor | Remember | CO4 | AEEB15.10 |
| 7 | Derive the expression for power developed in a synchronous motor, various conditions for maximum power developed. | Understand | CO4 | AEEB15.11 |
| 8 | Describe how a synchronous motor can be operated as a synchronous condenser | Understand | CO4 | AEEB15.10 |
| 9 | Derive the expression for power in terms of load angle, for a salient pole synchronous motor working at a lagging pf. Assume armature resistance may be neglected. | Understand | CO4 | AEEB15.10 |
| 10 | What are the advantages and disadvantages of the synchronous motor? | Remember | CO4 | AEEB15.10 |
| 11 | Explain the power circle diagram of the synchronous motor. | Understand | CO4 | AEEB15.11 |
| 12 | Explain the effect of excitation armature current and power factor | Remember | CO4 | AEEB15.11 |
| 13 | Draw and explain V and inverted V curves of synchronous motor | Understand | CO4 | AEEB15.11 |
| 14 | Draw and explain constant power lines of synchronous motor | Remember | CO4 | AEEB15.11 |
| 15 | Compare three phase induction motor and synchronous motor | Understand | CO4 | AEEB15.11 |
| 16 | Explain the merits and demerits of synchronous motors | Remember | CO4 | AEEB15.11 |
| 17 | Explain the effect of load on a synchronous motor | Understand | CO4 | AEEB15.11 |
| 18 | Demonstrate the armature reaction in synchronous motor | Understand | CO4 | AEEB15.11 |
| 19 | List the applications of synchronous motor | Remember | CO4 | AEEB15.11 |
| 20 | List the applications of synchronous condenser | Understand | CO4 | AEEB15.11 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | A 2.3 kV, 3-phase, star-connected synchronous motor has $Z_s$= (0.2+j2.2) Ω/phase. The motor is operating at 0.5 power factor leading with a line current of 200 A. Determine the generated EMF per phase | Understand | CO4 | AEEB15.10 |

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| 2 | A 3-phase, 415V, 6-pole, 50hz, star-connected synchronous motor has EMF of 520V (L-L). the stator winding has a synchronous reactance of 2ohms per phase and the motor develops a torque of 220N-m.the motor is operating at 415V,50hz bus (a) calculate the current drawn from the supply and it's power factor (b) draw the phasor diagram showing all the relevant quantities. | Understand | CO4 | AEEB15.10 |
| 3 | A 500V, 6-pole, 3-phase, 50hz, star-connected synchronous motor has a resistance and synchronous reactance of 0.3Ω and 3Ω per phase respectively. The open-circuit voltage is 600v. If the friction and core losses total 1kw,calculate the line current and power factor when the motor output is 100hp. | Understand | CO4 | AEEB15.10 |
| 4 | A 50hz, 4-pole, 3-Φ, and star-connected synchronous motor has a synchronous reactance of 12.0Ω/phase and negligible armature resistance. The excitation is such as to give an open-circuit voltage of 13.2kv.the motor is connected to 11.5KV, 50hz supply. What maximum load can the motor supply before losing synchronism? What is the corresponding motor torque, line current and power factor? | Understand | CO4 | AEEB15.10 |
| 5 | The excitation of a 415V, 3-phase, and mesh connected synchronous motor is such that the induced EMF is520V.the impedance per phase is (0.5+j4.0) Ω. If the friction and iron losses are constant at 1000watts, calculate the power output, line current, power factor and efficiency for maximum power output? | Understand | CO4 | AEEB15.10 |
| 6 | A 75 KW 3phase Y connected, 50hz, 440V cylindrical rotor synchronous motor operates at rated condition with 0.8pf leading. The motor efficiency excluding field and stator losses, is 95% and Xs=2.5Ω calculate (i) mechanical power developed (ii) armature current (iii) back EMF (iv) power angle and (v)max or pull out toque of the motor. | Understand | CO4 | AEEB15.10 |
| 7 | A 3 -phase 150kw 2300 V 50Hz 1000rpm salient pole synchronous motor has $X_d$=32ohms/ph and $X_q$=20ohm/ph. Neglecting losses ,calculate the torque developed by the motor if field excitation is so adjusted as to make the back EMF twice the applied voltage and $\alpha$=60°. | Understand | CO4 | AEEB15.10 |
| 8 | A 3300v, 1.5 MW, 3 phase, Y connected synchronous motor has $X_d$=4ohm/ph and $X_q$=3ohm/ph. Neglecting losses, calculate the excitation EMF when motor supplies rated load at Unity power factor. Calculate the maximum mechanical power which the motor would develop for this field excitation. | Understand | CO4 | AEEB15.10 |
| 9 | The input to an 11000V, 3 phase star connected synchronous motor is 60A. The effective resistance and synchronous reactance per phase are respectively 1 ohm and 30ohms. Find (i) the power supplied to the motor (ii) mechanical power developed and (iii) induced EMF for a power factor of 0.8 leading | Understand | CO4 | AEEB15.10 |
| 10 | A synchronous motor having 40% reactance and a negligible resistance is to be operated at rated load at (i) UPF (ii) 0.8 p.f lag (iii) 0.8pf lead. What are the values of induced EMF? Indicate assumptions made if any. | Understand | CO4 | AEEB15.10 |

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| 11 | A 500V, 6-pole, 3-phase, 50hz, star-connected synchronous motor has a resistance and synchronous reactance of 0.29Ω and 3.5Ω per phase respectively. The open-circuit voltage is 650V. If the friction and core losses total 1kw,calculate the line current and power factor when the motor output is 110HP. | Understand | CO4 | AEEB15.10 |
| 12 | A 50hz, 6-pole, 3-Φ, and star-connected synchronous motor has a synchronous reactance of 12.2Ω/phase and negligible armature resistance. The excitation is such as to give an open-circuit voltage of 13.4kv.the motor is connected to 11.9KV, 50hz supply. What maximum load can the motor supply before losing synchronism? What is the corresponding motor torque, line current and power factor? | Understand | CO4 | AEEB15.10 |
| 13 | The excitation of a 415v, 3-phase, and mesh connected synchronous motor is such that the induced EMF is520v.the impedance per phase is (0.5+j4.0) Ω. If the friction and iron losses are constant at 1000watts, calculate the power output, line current, power factor and efficiency for maximum power output? | Understand | CO4 | AEEB15.10 |
| 14 | A 76 KW 3phase Y- connected, 50Hz, 415V cylindrical rotor synchronous motor operates at rated condition with 0.8pf leading. The motor efficiency excluding field and stator losses, is 96% and Xs=2.55Ωcalculate (i) mechanical power developed (ii) armature current (iii) back EMF (iv) Power angle and (v) Max or pull out toque of the motor. | Understand | CO4 | AEEB15.10 |
| 15 | A 500V, 6-pole, 3-phase, 50hz, star-connected synchronous motor has a resistance and synchronous reactance of 0.36 Ω and 3.9Ω per phase respectively. The open-circuit voltage is 600V. If the friction and core losses total 1kw,calculate the line current and power factor when the motor output is 115HP. | Understand | CO4 | AEEB15.10 |
| **MODULE - V** | | | | |
| **SINGLE PHASE INDUCTION MOTOR** | | | | |
| **PART - A (SHORT ANSWER QUESTIONS)** | | | | |
| 1 | Compare capacitor start and capacitor run induction motor. | Understand | CO5 | AEEB15.14 |
| 2 | Demonstrate principle of operation of shaded pole induction motor? | Understand | CO5 | AEEB15.14 |
| 3 | What is the function of capacitor in a single phase induction motor? | Understand | CO5 | AEEB15.14 |
| 4 | Explain the importance of auxiliary winding | Remember | CO5 | AEEB15.14 |
| 5 | Explain the importance of main winding | Remember | CO5 | AEEB15.14 |
| 6 | Demonstrate split phase induction motor? | Understand | CO5 | AEEB15.14 |
| 7 | Why starting torque in capacitor start induction motor is more than resistance split phase induction motor? | Understand | CO5 | AEEB15.14 |
| 8 | What happens when the auxiliary winding of a capacitor motor is disconnected during running condition? | Remember | CO5 | AEEB15.14 |
| 9 | What are the advantages and disadvantages of capacitor start induction motor? | Understand | CO5 | AEEB15.14 |
| 10 | What are the applications of capacitor start induction motor | Remember | CO5 | AEEB15.14 |

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| 11 | What are the applications of capacitor start and run induction motor | Remember | CO5 | AEEB15.14 |
| 12 | Write short notes on double revolving field theory | Understand | CO5 | AEEB15.13 |
| 13 | Write short notes on cross revolving field theory | Understand | CO5 | AEEB15.13 |
| 14 | What are the applications of split phase induction motor | Understand | CO5 | AEEB15.14 |
| 15 | Why singe phase induction motor has low power factor? | Remember | CO5 | AEEB15.14 |
| 16 | Explain the importance of centrifugal switch | Remember | CO5 | AEEB15.14 |
| 17 | What is the starting torque of capacitor start motor? | Remember | CO5 | AEEB15.14 |
| 18 | Why capacitor is used in motor | Remember | CO5 | AEEB15.14 |
| 19 | Discuss the importance of shaded winding in shaded pole induction motor | Remember | CO5 | AEEB15.14 |
| 20 | List out four applications of shaded pole induction motor | Remember | CO5 | AEEB15.14 |
| **PART – B (LONG ANSWER QUESTIONS)** | | | | |
| 1 | Discuss in detail about the split-phase motors | Remember | CO5 | AEEB15.14 |
| 2 | Describe the phase control of single phase induction motor | Understand | CO5 | AEEB15.14 |
| 3 | Discuss about torque-speed curve of single phase induction motor | Understand | CO5 | AEEB15.14 |
| 4 | Show that the starting torque of a single phase-phase induction motor is zero. | Remember | CO5 | AEEB15.14 |
| 5 | Explain the constructional features and principle of operation of a single phase induction motor | Understand | CO5 | AEEB15.14 |
| 6 | Using double revolving field theory explain the torque-slip characteristic of a single phase induction motor and prove that it cannot produce ant starting torque | Remember | CO5 | AEEB15.14 |
| 7 | Derive the equivalent circuit of a single phase induction motor with the help of double revolving field theory. | Understand | CO5 | AEEB15.15 |
| 8 | Describe the principle of operation and characteristics of split phase induction motor | Understand | CO5 | AEEB15.14 |
| 9 | Explain the operation and characteristics of capacitor start induction motor | Remember | CO5 | AEEB15.14 |
| 10 | State the reasons for the inferior performance of single phase induction motors compared to three phase induction motors. | Understand | CO5 | AEEB15.13 |
| 11 | Explain the operation and torque speed characteristics of capacitor start and run induction motor | Understand | CO5 | AEEB15.13 |
| 12 | Describe the principle of operation and characteristics of shaded pole induction motor | Understand | CO5 | AEEB15.14 |
| 13 | Draw and explain the equivalent circuit of single phase induction motor | Understand | CO5 | AEEB15.15 |
| 14 | Compare single phase induction motor with three phase induction motor | Remember | CO5 | AEEB15.13 |
| 15 | Explain the various losses in single phase induction motor | Understand | CO5 | AEEB15.13 |
| 16 | List the advantages of split phase induction motor | Remember | CO5 | AEEB15.14 |
| 17 | List the applications of shaded pole induction motor | Remember | CO5 | AEEB15.14 |
| 18 | Explain the equivalent circuit of single phase induction motor | Remember | CO5 | AEEB15.15 |

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| 19 | Explain the performance characteristics of single phase induction motor | Remember | CO5 | AEEB15.15 |
| 20 | Compare three phase and single phase induction motors | Remember | CO5 | AEEB15.14 |
| **PART - C (ANALYTICAL QUESTIONS)** | | | | |
| 1 | A 2-winding single-phase motor has the main auxiliary winding currents $I_m$=15 A and $I_a$=7.5 A at stand-still. The auxiliary winding current leads the main winding current by $\alpha=45^0$ electrical. The two winding are in space quadrature and the effective number of turns are $N_m$=80 and $N_a$=100. Compute the amplitudes of the forward and backward stator MMF waves. Also determine the magnitude of the auxiliary current and its phase angle difference α with the main winding current if only the backward field is to be present. | Understand | CO5 | AEEB15.14 |
| 2 | The following data pertains to a 230 V, 50 Hz capacitor start single phase induction motor at stand still. Main winding excited alone=100V, 2A, 40 W. Auxiliary winding excited alone= 80 V, 1 A, 50 W<br>Determine the value of capacitance for determining the maximum torque. | Understand | CO5 | AEEB15.15 |
| 3 | Find the mechanical power output of 185kw, 4 pole, 110V, 50Hz single phase induction motor, whose constants are given below at a slip of 0.05.<br>$R_1$=1.86 Ω, $X_1$=2.56 Ω, $X_\phi$=53.5 Ω, $R_2$=3.56 Ω , $X_2$=2.56 Ω core loss 3.5w, friction and wind age loss 13.5w | Understand | CO5 | AEEB15.15 |
| 4 | A 250w, 230V, 50Hz capacitor start motor has the following constants for the main and auxiliary windings: main winding, $Z_m$= (4.5+3.7j) Ω. Auxiliary winding $Z_a$= (9.5+3.5i) Ω. Determine the value of the starting capacitor that will place the main and auxiliary winding currents in quadrature at starting. | Understand | CO5 | AEEB15.15 |
| 5 | A single phase induction motor has stator windings in space quadrature and is supplied with a single phase voltage of 200V at 50Hz. The standstill impedance of the main winding is (5.2+10.1i) and the auxiliary winding is (19.7+14.2j). Find the value of capacitance to be inserted in the auxiliary winding for maximum starting torque. | Understand | CO5 | AEEB15.15 |
| 6 | What is the motor torque $T_m$ required to accelerate an initial load of $3*10^{-4}$ kg $m^2$ from $f_1$ = 1500 Hz to $f_2$ = 2500 Hz during 100 ms. The frictional torque $T_f$ is 0.05 N-m and the step angle is $1.7^{\circ}$. | Understand | CO5 | AEEB15.15 |
| 7 | A 230 V, 4-pole, 50Hz single phase induction motor has the following data at standstill. Main winding (1.5+j4.0) Ω, starting winding (2.2+j5.5) Ω. For making the motor develop maximum starting torque, find the value of (i) resistor (ii) capacitor in series with the starting winding. | Understand | CO5 | AEEB15.15 |
| 8 | A 230 V, 380 W, 50 Hz, 4 pole, single phase induction motor gave the following test results:<br>No load test: 230 V, 84 W, 2.8 A<br>Blocked rotor test: 110 V, 460 W, 6.2 A<br>The stator winding resistance is 4.6 Ω and during the blocked rotor test, the auxiliary winding is open. Determine the equivalent circuit parameters. | Understand | CO5 | AEEB15.15 |

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| 9 | A 230 V, 50 Hz, 4 pole, class A, single phase induction motor has the following parameters at an operating temperature of $63^0$C: $R_{1m}$= 2.51Ω, $R_{2m}$ = 7.81Ω, $X_m$= 150.88Ω, $X_{1m}$= 4.62Ω, $X'_2$= 4.62Ω Determine the main winding current and power factor when the motor is running at a slip of 0.05 at the specified temperature of $63^0$ C. | Understand | CO5 | AEEB15.15 |
| 10 | A 125 W, 4 pole, 110 V, 50 Hz single phase induction motor delivers rated output at a slip of 6%. The total copper loss at full load is 25 Watts. Calculate the full load efficiency and the rotor copper loss caused by the backward field. Rotational losses may be assumed to be 25 Watts. Neglect stator copper loss. | Understand | CO5 | AEEB15.14 |
| 11 | The following data pertains to a 230 V, 50 Hz capacitor start single phase induction motor at stand still. Main winding excited alone=110V, 2.5A, 39 W. Auxiliary winding excited alone= 70 V, 1.5 A, 49 W Determine the value of capacitance for determining the maximum torque. | Understand | CO5 | AEEB15.15 |
| 12 | Find the mechanical power output of 160 KW, 4 pole, 120V, 50Hz single phase induction motor, whose constants are given below at a slip of 0.06. $R_1$=1.80 Ω, $X_1$=2.50 Ω, $X_\phi$=53.4 Ω, $R_2$=3.50 Ω , $X_2$=2.50 Ω core loss 3.5W, friction and wind age loss 13.3 W | Understand | CO5 | AEEB15.15 |
| 13 | A 230 V, 4-pole, 50Hz single phase induction motor has the following data at standstill. Main winding (2.5+j3.5) Ω, starting winding (4+j5) Ω. For making the motor develop maximum starting torque, find the value of (i) resistor (ii) capacitor in series with the starting winding. | Understand | CO5 | AEEB15.15 |
| 14 | The following data pertains to a 230 V, 50 Hz capacitor start single phase induction motor at stand still. Main winding excited alone=120V, 2.3A, 45 W. Auxiliary winding excited alone= 60 V, 2.5 A, 40 W Determine the value of capacitance for determining the maximum torque. | Understand | CO5 | AEEB15.15 |
| 15 | A 140 W, 4 pole, 120 V, 50 Hz single phase induction motor delivers rated output at a slip of 5%. The total copper loss at full load is 20 Watts. Calculate the full load efficiency and the rotor copper loss caused by the backward field. Rotational losses may be assumed to be 22 Watts. Neglect stator copper loss. | Understand | CO5 | AEEB15.14 |

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