Code No: R2022024 **R20** **SET - 1**

II B. Tech II Semester Regular/Supplementary Examinations, July- 2023

INDUCTION AND SYNCHRONOUS MACHINES

(Electrical and Electronics Engineering)

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

Answer any **FIVE** Questions each Question from each unit

All Questions carry **Equal** Marks

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UNIT-I

1 a) Why slip ring induction motors are more expensive than squirrel cage motors of the same rating? Explain. [7M]

b) A 25 hp, 400 V, 50 Hz, 4-pole, star connected induction motor has the following impedances per phase in Ω referred to the stator side: Rs= 0.641 Ω, R_r^1= 0.322Ω, Xs=1.106 Ω, X_r^1= 0.464 Ω and Xm = 26.30 Ω . Rotational losses are assumed constant and are 1.1 kW and the core losses are assumed negligible. If the slip is 2.2% at rated voltage and frequency , Find i) speed ii) stator current iii) power factor iv) output and input power and v) efficiency of motor. [7M]

Or

2 a) Develop the equivalent circuit of a three phase induction motor. Explain how this equivalent circuit is similar to the transformer equivalent circuit? [7M]

b) A 3-phase Induction Motor has a star-connected rotor. The rotor e.m.f. between the slip rings at standstill is 50 V. The rotor resistance and standstill reactances are 0.5 Ω and 3 Ω respectively. Find [7M]

(i) Rotor current per phase at starting if a star connected rheostat of resistance 6Ω per phase is connected across the slip rings

(ii) Full-load rotor current and rotor power factor if full-load slip is 4%

(iii) Rotor e.m.f. per phase under full-load condition.

UNIT-II

3 a) Explain in detail about torque (vs) slip and torque (vs) speed characteristics of 3-phase Induction Motor. [7M]

b) For a three phase induction motor, the rotor ohmic loss at maximum torque is 16-times that at full load torque. The slip at full load torque is 0.03. If the stator resistance and rotational losses are neglected, then calculate [7M]

(i) The slip at maximum torque

(ii) The maximum torque in terms of full load torque

(iii) The starting torque in terms of full load torque

Or

4 a) Explain the principle of speed control of a 3-phase induction motor by V/f method and draw the corresponding torque-speed characteristics. [7M]

b) A 4-pole, 50 Hz, 3-phase induction motor develops a maximum torque of 120 NM at 1460 r.p.m. The resistance of the star connected rotor is 0.35Ω/phase. Determine the value of resistance that must be inserted in series, with each rotor phase to produce a starting torque equal to half the maximum torque. [7M]
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UNIT-III

5 a) Why starters are necessary for starting the Induction Motors? What are various types of starters used for squirrel cage motors? Discuss them. [7M]

b) Estimate the starting torque as a percentage of full-load torque for a 3-phase Induction motor for the following methods of starting: [7M]
a) Direct on line, b) Star-Delta, and c) Autotransformer which limits the starting current to twice the full load current. The full load slip is 0.03 and the short-circuit current is six times the full-load current.

Or

6 a) Explain the constructional features and working principle of single phase induction motor. [7M]

b) The following data pertaining to a single phase, 4-pole Induction Motor: [7M]
Output = 410 W; Supply voltage= 230 V; Frequency=50 Hz;
Input Current=3.2 A; Power factor = 0.7; Speed= 1410 RPM
Calculate (i) The efficiency of the motor and
(ii) The slip of the motor when delivering rated output.

UNIT-IV

7 a) Explain the MMF method of determining the voltage regulation of alternator. [7M]

b) Two identical three phase synchronous generators operating in parallel share equal loads of 2000kW at 11 kV and 0.8 lagging power factor. The armature current of the first generator is 100A at lagging power factor. Determine the armature current of the second generator and the power factor at which each machine operates. [7M]

Or

8 a) Derive the expression for the EMF induced in an alternator. Discuss the role of different factors which appear in the expression. [7M]

b) A 5 kVA, 220 V, star connected three phase salient pole alternator with direct axis and quadratic axis reactances of 12 Ω and 7 Ω respectively, delivers full load current unity power factor. Calculate the excitation voltage. Neglect armature resistance. [7M]

UNIT-V

9 a) With the help of a neat vector diagram, explain the operation of synchronous motor as synchronous condenser. [7M]

b) A 2500 V, three phase star -connected synchronous motor has a resistance of 0.35Ω per phase and synchronous reactance of 2.2 Ω per phase. The motor is operating at 0.75 power factor leading with a line current of 250 A. Determine the excitation voltage per phase. [7M]

Or

10 a) Derive the expression for the maximum power developed by a synchronous motor. [7M]

b) A 2 kV, 3-phase star-connected synchronous motor has an effective resistance and synchronous reactance per phase of 0.3 Ω and 2.4 Ω respectively. The input is 800 kW at normal voltage and induced line e.m.f is 2500 V. Calculate line current and power factor. [7M]

Code No: R2022024 **R20** **SET - 2**

II B. Tech II Semester Regular/Supplementary Examinations, July- 2023
INDUCTION AND SYNCHRONOUS MACHINES
(Electrical and Electronics Engineering)

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

Answer any **FIVE** Questions each Question from each unit
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UNIT-I

1 a) Explain, why the speed of 3-phase induction motor cannot be equal to synchronous speed? [7M]

b) A 25 hp, 400 V, 50 Hz, 4-pole, star connected induction motor has the following impedances per phase in ohms referred to the stator side: Rs = 0.581 Ω, R_r^1= 0.431Ω: Xs=1.106 Ω, X_r^1= 0.464 Ω and Xm = 26.30Ω. Rotational losses are assumed constant and are 1.5 kW and the core losses are assumed negligible. If the slip is 2.2% at rated voltage and frequency , find i) speed ii) stator current iii) power factor iv) output and input power and v) efficiency of motor. [7M]

Or

2 a) Explain in detail the constructional features of wound rotor three phase Induction motor. [7M]

b) In a 6-pole, 3-phase, 50-Hz Induction Motor with star connected rotor, the rotor resistance per phase is 0.3Ω, the reactance at standstill is 1.5 Ω per phase. The e.m.f. between the slip rings on open circuit is 175 V. Calculate [7M]
(i) Rotor e.m.f. per phase
(ii) Rotor frequency and reactance at a speed of 950 RPM.

UNIT-II

3 a) Explain how the circle diagram for a poly-phase induction motor can be drawn from its test data. [7M]

b) A 3-phase, 400 V, 4-pole, 50-Hz, Induction Motor has a star-connected stator and rotor. The rotor resistance and standstill reactance per phase are 0.25 Ω and 1.2 Ω respectively. The ratio of stator to rotor turns is 1.3. The full-load slip is 4 %. Calculate [7M]
(i) The power and torque developed at full-load
(ii) Maximum torque and speed at which it occurs.

Or

4 a) State the effects of increasing rotor resistance on starting current, starting torque, maximum torque and full-load slip of a 3-phase induction motor. [7M]

b) What is the purpose of using deep bar cage rotors? Explain the construction and working principle of a deep-bar cage motor. [7M]

UNIT-III

5 a) Explain in detail about the various starting methods of 3-phase induction motors. [7M]

b) A 50 kVA, 400 V, 3-phase, 50-Hz squirrel cage Induction Motor has full-load slip of 5%. Its standstill impedance is 0.866 Ω/ 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 torque. [7M]

Or
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6 a) Explain the working principle of A.C series motor. [7M]

b) A 230 V, 50 Hz, 4-pole single phase induction motor has the following equivalent circuit impedances referred towards stator side: [7M]
R_{1m}= 2.2 Ω ; R_2^1 = 4.5 Ω; X_{1m} = 3.1Ω; X_2^1 = 2.6 Ω and X_M = 80 Ω;
Friction, windage and core loss = 40 W
For a slip of 0.03 pu, calculate a) input current b) power factor c) developed power d) output power and e) efficiency

UNIT-IV

7 a) Explain the effect of increasing driving torque and speed of one of the alternators in a parallelly connected two alternators. [7M]

b) What is a distribution factor? Derive an expression for distribution factor of winding having 'Q' slots per pole per phase and a slot angle of 'β'. [7M]

Or

8 a) Explain the Potier triangle method of determining the voltage regulation of alternator. [7M]

b) A 100 kVA, 3000V, 50Hz 3-phase star connected alternator has effective armature resistance of 0.2 ohms. The field current of 40 A produce short-circuit current of 200 A and an open circuit e.m.f of 1040 V (line). Calculate the full load voltage regulation at 0.8 lagging and 0.8 leading power factors. Draw phasor diagrams. [7M]

UNIT-V

9 a) Explain the various starting methods of synchronous motor. [7M]

b) A 2500 V, three phase, star- connected synchronous motor has a resistance of 0.4Ω per phase and synchronous reactance of 2.2 Ω per phase. The motor is operating at 0.8 power factor leading with a line current of 260 A. Determine the excitation voltage per phase. [7M]

Or

10 a) Explain the operation of synchronous motor with variable excitation at constant load. [7M]

b) The input to an 11000V, 3 phase star connected synchronous motor is 60A. The effective resistance and synchronous reactance per phase are respectively 1 Ω and 30Ω. Find the power supplied to the motor, and the induced electromotive force for a power factor of 0.8 i) lagging ii) leading [7M]

Code No: R2022024 **R20** **SET - 3**

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Answer any **FIVE** Questions each Question from each unit
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UNIT-I

1 a) Describe the principle of operation of three phase induction motor. Explain why the rotor is forced to rotate in the direction of rotating magnetic field. [7M]

b) The open-circuit voltage across the slip rings of a 100 HP star connected Induction Motor is 273 V at standstill. What resistance in rotor circuit will reduce its full-load speed by 25%? The full-load slip is 2% with no additional rotor resistance. [7M]

Or

2 a) Develop an expression for the frequency of rotor currents in a 3-phase Induction Motor. [7M]

b) A 25 hp, 400 V, 50 Hz, 4-pole, star connected induction motor has the following impedances per phase in ohms referred to the stator side: Rs= 0.641 Ω, R_r^1 = 0.432Ω: Xs=1.106 Ω, X_r^1 = 0.544 Ω and Xm = 25.30 Ω. Rotational losses are assumed constant and are 1.1 kW and the core losses are assumed negligible. If the slip is 2.2% at rated voltage and frequency, find i) speed ii) stator current iii) power factor iv) output and input power and v) efficiency of motor. [7M]

UNIT-II

3 a) Derive an expression for the torque of an Induction motor and obtain the condition for maximum Torque. [7M]

b) A 3-phase, 400 V, 4-pole, 50-Hz, Induction Motor has a star-connected stator and rotor. The rotor resistance and standstill reactance per phase are 0.25 Ω and 1.2 Ω respectively. The ratio of stator to rotor turns is 1.5. The full-load slip is 6 %. Calculate [7M]
   (i) The power and torque developed at full-load
   (ii) Maximum torque and speed at which it occurs.

Or

4 Draw the circle diagram from no-load and short circuit test on a 3-phase, 14.92 kW, 440V, 6-pole induction motor from the following results: [14M]
No-load test : 400V , 11A, PF=0.2
Short-circuit test : 100V, 25A, PF=0.4
Rotor Cu losses at stand still is half the total Cu losses from the circle diagram,
Determine (i) Line current, slip, efficiency and pf at full load
(ii) Maximum torque.
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UNIT-III

5 a) Explain the operation of Auto transformer starter of a 3-phaseinduction with a neat diagram and listout its advantages and disadvantages. [7M]

b) A squirrel cage Induction Motor, when started by means of a star-delta starter takes 200% full-load current (line) and develops 44% of full-load torque at starting. Calculate the starting torque and current, if an auto-transformer with 75% tapping were employed. [7M]

Or

6 a) Explain with reasons, why single phase induction motors are not self starting. [7M]

b) A 4-pole, 110 V, 140 W single phase Induction Motor runs at 5% slip at rated output. Total copper losses at full load are 28W and rotational losses are 28W. Calculate the full-load efficiency and rotor copper losses caused by backward field. Neglect stator copper losses. [7M]

UNIT-IV

7 a) Explain the effect of increasing excitation of one of the alternators when two alternators are connected in parallel. [7M]

b) Two similar 400V, 3-ph alternators share equal kW power delivered to a balanced 3-ph, 50kw, 0.8pf lag load. If the power factor of one is 0.95 lag, find the power factor and the current supplied by the other machine. [7M]

Or

8 a) Explain the EMF method of determining the voltage regulation of alternator. [7M]

b) A 3-phase, 200 kVA, 1.1 kV, 50 Hz star connected alternator having an effective per phase resistance of 0.62 Ω gave the following results: [7M]

Filed current (A)	20	35	50	80	100	120
Open circuit Voltage(V)	692.82	1120	1450	1750	1953	2180
Short circuit current (A)	0					

Using MMF method, find voltage regulation at 100 A (i) 0.8 lagging (ii) 0.8 leading power factors.

UNIT-V

9 a) Draw the phasor diagram of 3-phase synchronous motor. Explain the effect of (i) change in excitation if load is constant (ii) change of load if excitation is constant. [7M]

b) A 3-phase star connected 440 V; the synchronous motor takes a power input of 5 kW at rated voltage. It's synchronous reactance is 5 Ω per phase and resistance is negligible. If its excitation voltage is adjusted equal to rated voltage of 400V, compute the load angle, power factor and armature current. [7M]

Or

10 a) What is meant by hunting in a Synchronous motor? Explain in detail. [7M]

b) The input to an 11 kV, 3-phase star connected synchronous motor is 60A. The effective resistance and synchronous reactance per phase are respectively 1 Ω and 30Ω. Find the power supplied to the motor, and the induced electromotive force for a power factor of 0.8 i) lagging ii) leading [7M]

Code No: R2022024 **R20** **SET - 4**

II B. Tech II Semester Regular/Supplementary Examinations, July- 2023

INDUCTION AND SYNCHRONOUS MACHINES

(Electrical and Electronics Engineering)

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

Answer any **FIVE** Questions each Question from each unit
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UNIT-I

1 a) Show that a rotating magnetic field can be produced by the use of 3-phase currents of equal magntude. [7M]

b) A 3-phase Induction Motor has a star-connected rotor. The rotor e.m.f. between the slip rings at standstill is 60 V. The rotor resistance and standstill reactances are 0.3 Ω and 2 Ω respectively. Find [7M]

(i) Rotor current per phase at starting if a star connected rheostat of resistance 6Ω per phase is connected across the slip rings

(ii) Full-load rotor current and rotor power factor if full-load slip is 5%.

(iii) Rotor e.m.f. per phase under full-load condition.

Or

2 a) Draw and explain the equivalent circuit of a 3-phase induction motor. [7M]

b) The open-circuit voltage across the slip rings of a 110 HP star connected Induction Motor is 275 V at standstill. What resistance in rotor circuit will reduce its full-load speed by 30%? The full-load slip is 3% with no additional rotor resistance. [7M]

UNIT-II

3 a) Explain the no-load and blocked rotor tests and also procedure to predetermine the efficiency using circle diagram of a three phase induction motor. [7M]

b) For a three phase induction motor, the rotor ohmic loss at maximum torque is 15 times that at full load torque. The slip at full load torque is 0.05. If the stator resistance and rotational losses are neglected, then calculate [7M]

(i) The slip at maximum torque

(ii) The max. torque in terms of full load torque

(iii) The starting torque in terms of full load torque

Or

4 a) Explain the phenomenon of crawling and cogging in a three phase induction motor. [7M]

b) A three phase induction motor has a starting torque of 100% and a maximum torque of 200% of the full-load torque. Determine : i) slip at which maximum torque occurs ii) full-load torque and iii) rotor current at starting in per unit of full-load rotor current. [7M]

UNIT-III

5 a) How is the speed of a 3-phase induction motor controlled by its stator voltage control? [7M]
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b) The ratio of maximum torque to full-load torque in a 3-phase squirrel cage Induction Motor is 2.2: 1. The rotor resistance and standstill reactance per phase are 0.5 Ω and 5 Ω respectively. Determine the ratio of actual starting torque to full-load torque for the following cases: [7M]
(i) Direct Starting (ii) Star-Delta Starting
(iii) Auto transformer starting with 70% tapping.

Or

6 a) Using double field revolving field theory explain the torque-slip characteristics of a single phase induction motor and prove that it cannot produce starting torque? [7M]

b) A 230 V, 50 Hz, 4-pole single phase induction motor has the following equivalent circuit impedances referred towards stator side: [7M]
R_{1m}= 2.3 Ω ; R_2^1 = 4.5 Ω; X_{1m} = 3Ω; X_2^1 = 2.6 Ω and X_M = 80 Ω;
Friction, windage and core loss = 60 W
For a slip of 0.04 pu, calculate i) input current ii) power factor iii) developed power iv) output power and v) efficiency

UNIT-IV

7 a) What are the effects of change of excitation and mechanical power input on alternators operated in parallel? [7M]

b) Two star-connected synchronous generators connected in parallel have an emf of 1200 V per phase share a common star-connected share impedance (2 +j1.0) Ω/ phase. The synchronous impedances of the machines are Zs_1 = 0.1+j2 Ω/phase and Zs_2= (0.2+j3) Ω/phase respectively. Determine the common terminal voltage, power outputs and no-load circulating current when two machines internal emfs have a phase divergence 5^0. [7M]

Or

8 a) What is the necessity of parallel operation of alternator and state the requirement of paralleling alternator. [7M]

b) Two alternators running in parallel supply lighting load of 2500 KW and a motor load of 5000 KW at 0.707 P.F. one machine is loaded to 4000 KW at a P.F. of 0.8 lagging. What is the KW output and P.F. of the other machine? [7M]

UNIT-V

9 a) Explain about synchronous condensers. [7M]

b) A three-phase, star-connected synchronous motor has Z=(0.5+j5)Ω and taking an input power of 1500 kW when back emf is 4000V. Calculate (i) Line current (ii) power factor for the above condition [7M]

Or

10 a) Explain the operation of synchronous motor with variable excitation at constant load. [7M]

b) A 2 kV, 3-phase star-connected synchronous motor has an effective resistance and synchronous reactance per phase of 0.4 Ω and 2.6 Ω respectively. The input is 900 kW at normal voltage and induced line e.m.f is 2500 V. Calculate line current and power factor. [7M]