TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machines II *(EE 601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the different conditions to be satisfied for parallel operation of alternators? Describe in detail the full process of synchronization using dark lamp method. [8]

   b) The data obtained on 100 kVA, 1100V, Y-connected, 3-phase alternators are:
   DC resistance Test: Voltage between lines 6V DC, current in lines = 6A
   Open Circuit Test: Field Current = 12.5 A DC, line voltage = 420 V AC
   Short Circuit Test: Field Current = 12.5 A DC, line current = rated current
   Calculate the voltage regulation of alternator at 0.8 p.f. lagging. Take effective resistance to be 1.667 times of DC resistance. [6]

2. a) State the characteristic features and application of synchronous motor. Explain the effect of excitation on armature current and power factor on synchronous motor with diagram. [8]

   b) A 4KVA, 110V, 50Hz, 3 phase star connected synchronous motor has Xd = 3 ohm/phase and Xq = 2 ohm/phase, when the motor is delivering full load at 0.8 pf. lagging at rated voltage. Calculate the excitation emf, load angle and maximum power that motor can develop. [6]

3. a) A 250 KW, 230 V, 50 Hz, capacitor start motor has following impedance: Main Winding, Zm = (4.5 + j3.7) ohm and Auxiliary winding Za = (9.5 + j3.5) ohm. Determine the value of capacitor to be connected in series with auxiliary winding that will place main and auxiliary winding currents in quadrature at starting. [6]

   b) Write short notes on: [6]

   (i) AC Servomotor
   (ii) Hysteresis motor

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1½ hrs.

Subject: - Electric Machines II *(EE 601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) In what circumstances, terminal voltage of a three-phase synchronous generator could be less than or more than the internal induced voltage? Explain with circuit diagram and phasor diagram. [6]

   b) A 3-phase, 10KVA, 400V, 50Hz star-connected synchronous alternator supplies the rated load at 0.8 power factor lagging. If the armature resistance is 0.5Ω and synchronous reactance is 10Ω, find the power angle and voltage regulation. [8]

2. a) State the characteristic features of synchronous motor and explain how a synchronous motor can be operate to draw lagging current as well as leading current. [7]

   b) A 6600V, 2MW, 3 phase star connected synchronous motor has Xd=5 ohm/phase and Xq=3.1 ohm/phase. Neglecting all losses. Calculate the excitation e.m.f. when the motor supplies rated load at 0.8 p.f. [7]

3. a) A 250 W, 230 W, 50 Hz, single-phase capacitor start Induction motor has the following constants for its main and starting windings: [6]

   Z_m=(4.5+j 3.5)Ω and Z_s=(9.5+j3.5)Ω. Determine the value of the starting capacitor that will place the main and starting winding currents in quadrature at starting.

   b) Explain the operating principle of split-phase capacitor start motor. [6]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1½ hrs.

Subject: - Electric Machines II *(EE 601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the construction and principle of operation of a three phase synchronous generator. [7]

   b) 3 phase star connected, 50Hz synchronous generator has direct axis and quadrature axis reactance of 0.6 pu and 0.45 pu. Draw the phasor diagram at full load 0.8 lagging and hence calculate. (i) load angle (ii) ld and lq (iii) open circuit voltage (iv) voltage regulation Resistance drop at full load is 0.015pu. [7]

2. a) Explain the principle of operation of shaded pole motor. [6]

   b) A three phase, star connected 1500 KVA, 13 KV, alternator has armature resistance of 0.9 ohm per phase and synchronous reactance of 8 ohm per phase. In each of the following cases if the alternator is supplying rated full load current at rated terminal voltage. Calculate emf generated and voltage regulation in each following cases:

   i) unity P.F.
   ii) 0.8 P.F. lagging [8]

3. a) Why are the single-phase induction motor not self-starting? How these can be made self starting. Explain one of them. [6]

   b) Explain how the damper winding on the rotor pole of a 3-phase synchronous motor can be used to make the motor self starting. [6]

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14 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machines II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) State the required conditions for the parallel operation of alternators. Also explain synchronizing process by three lamp method with neat sketch. [7]

   b) A star connected 50 kVA, 440V, 50 Hz alternator has effective armature resistance of 0.25 Ω per phase, synchronous reactance is 3.2 Ω per phase and the leakage reactance is 0.5 Ω per phase. At rated load and unity power factor, Determine: [7]

   (i) Internal emf
   (ii) No-load emf
   (iii)Percentage voltage regulation at full load

2. a) In what manner does a synchronous motor adjust itself to an increasing shaft load? [6]

   b) A 3.3 kV, 50 Hz star connected synchronous motor has a synchronous impedance of (0.8 + j 55) Ω. It is synchronized to 3.3 kV main from which it is drawing 750 kW at an excitation emf of 4.27 kV (line). Determine the armature current, power factor and power angle. Also find the mechanical power developed. If the stay load loss is 30 kW, find the efficiency. [8]

3. a) A 230 V, 50Hz, 4pole, class A, Single phase induction motor has the following parameters r_{1m} = 2.51Ω, r'_2 = 7.81 Ω, x_m = 150.88 Ω, x_{1m} = 4.62 Ω, x_2^1 = 4.62Ω. Determine the main winding current and power factor when the motor is running at a slip of 0.05. [6]

   b) How does double revolving field theory, describe the operation of single phase induction motor? Explain with proper diagrams and expressions. [6]

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14 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machines II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain load characteristics of synchronous generator. Why terminal voltage of a synchronous generator is greater than internal generated emf (E) in case of capacitive load? Explain with the help of armature reaction and phasor diagram. [8]

   b) A 3-phase, star connected synchronous generator is rated at 1.5 MVA, 11kV. The armature effective resistance and synchronous reactance are 1.2 Ω and 25 Ω respectively per phase. Calculate the percentage voltage regulation for a load of 1.4375 MVA at i) 0.8 p.f. lagging and ii) 0.8 p.f. leading. Also find out the p.f. at which regulation is zero. [6]

2. a) A synchronous motor can operate as both inductive and capacitive characteristics. Justify this statement with relevant diagrams. [7]

   b) A 25 MVA, 3-phase star connected 11 kV, 12 poles, 50 Hz salient pole synchronous motor has direct axis reactance of 48 ohm and quadrature axis reactance of 3.5 ohm per phase. The armature resistance being negligible. At rated load, unity power factor and rated voltage, Determine,

   (i) Excitation Voltage
   (ii) Maximum value of power angle and corresponding power [7]

3. a) Explain the operating principle of stepper motor and list their application. [6]

   b) Explain the operating principle and Speed-Torque Characteristics of Single Phase Capacitor start Capacitor run-Induction Motor with suitable diagram. [6]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Why the terminal voltage (V) of a synchronous generator is greater than the internal generated emf (E) in case of capacitive load? Explain it with the help of armature reaction and phasor diagram. [8]

   b) Explain the various factors which will affect the regulation of an alternator. [6]

2. a) Explain the functions of damper winding provided on pole face of rotor of a Synchronous motor. [6]

   b) A 30 MVA, 3 phase star connected 11 KV, 12 pole 50Hz salient pole synchronous motor has a direct axis reactance of 55 ohm and quadrature axis reactance of 4 ohm per phase. The armature resistance being negligible. At rated load, unity power factor and rated voltage. Determine (i) Excitation voltage (ii) The maximum value of power angle and corresponding power. [6]

3. a) Explain why single phase induction motor is not self starting? Also explain working principle and application of permanently split phase capacitor motor. [3+5]

   b) Explain operating principle of single stack stepper motor. [6]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define the pitch factor and distribution factor and their significance in synchronous machine. Derive the e.m.f equation of an alternator. [8]
   b) Three lamps can be used for synchronization of two alternators. Explain it with proper justification. [6]
2. a) Explain power angle characteristics of cylindrical rotor machine. [6]
   b) A four pole, single phase, 120 V, 50 H_2 induction motor gave the following standstill impedances when tested at rated frequency. Main winding: Z_n = (1.5+j4) ohms. Auxiliary winding: Z_a = (3+j6) ohms. If an external capacitor of 1000μF is inserted in series with the auxiliary winding to obtain higher starting torque. Calculate the percentage increase in starting torque. [6]
3. a) State and explain the double field revolving theory of single phase induction motor with detailed diagram. [8]
   b) "synchronous motor is not self starting" Explain it with proper justification. [6]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define armature reaction. Discuss the nature of armature reaction of an alternator for lagging, leading and unity power factor load. [6]

   b) A 3-phase star-connected alternator is rated at 1500 kVA, 12000 V. The armature effective resistance and synchronous reactance are 2 Ω and 25 Ω respectively per phase. Calculate the emf generated and percentage voltage regulation for a load of 1250 kW at power factors of: (i) 0.75 leading (ii) 0.75 lagging. [8]

2. a) Explain how a three-phase synchronous motor can be operated to draw lagging as well as leading current from the source. [6]

   b) A 3-phase, 5kVA, 208V, 4-pole, 50 Hz star connected synchronous motor has negligible armature winding resistance and synchronous reactance of 8 ohms per phase. It is operated from the 3-phase, 208V, 50Hz power supply and field excitation is adjusted to that the power factor is unity and the motor draw a power of 3 kW from the supply. [8]

      i) Find the back emf (or excitation) voltage and power angle.

      ii) Keeping the excitation voltage constant, the power angle is increased by 20% due to increase in load on the shaft. Calculate the new armature current and power factor.

3. a) The main winding and starting winding of a 50 Hz capacitor start single-phase induction motor have impedances as follow: [6]

   Main winding: (3+3j) ohm

   Starting winding: (7.5+j3) ohm

   Calculate the value of capacitor to be connected in series with the starting winding to produce a phase difference of 90° between main winding current and starting winding current at starting.

   b) Write short notes on: [2×3]

      i) AC servo motor

      ii) Stepper motor

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25 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the conditions to be fulfilled for operating two 3-phase alternators in parallel? Explain the process of synchronizing two alternators by three lamp method. [7]

   b) A 3-phase, star-connected 3-phase synchronous generator is rated as 1500 kVA, 11kV. The armature winding resistance is 0.8 ohm per phase and synchronous reactance is 4 ohms per phase. If the generator is supplying power to a three phase balanced load of (80+j60) ohm per phase at rated terminal voltage, calculate emf generated and voltage regulation. Is the generator overloaded OR under-loaded? Calculate the percentage by which it is overloaded OR under-loaded. [7]

2. a) Explain the effect of varying excitation on armature current and power factor in a synchronous motor. Draw V curves and state their significance. [7]

   b) A 660 V, 3-phase, star-connected synchronous motor draws 50 kW at power factor of 0.8 lagging. Find the new current and power factor when the back e.m.f increases by 25%.The machine has synchronous reactance of 3 Ω and effective resistance is negligible. [7]

3. a) Explain the double revolving field theory for operation of single phase induction motor. [6]

   b) Explain the construction and working principle of stepper motors. Also give some of its applications. [6]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is armature reaction? Explain the effect of armature reaction on the terminal voltage of an alternator at (i) Unity power factor load (ii) Leading power factor load and (iii) Lagging power factor load. Draw relevant phasor diagram. [8]

   b) A 3-phase, 5 KVA, 208 V, 4-pole, 50 Hz star connected synchronous machine has negligible stator winding resistance and synchronous reactance of 8Ω/phase. The machine is operated as generator in parallel with 3-phase, 208 V and 50Hz supply. Then, [6]

      i) Determine the excitation voltage and power angle when machine is delivering rated KVA at 0.8 pf lagging.

      ii) If the excitation is increased by 20% without changing prime mover power, find the stator current and power factor.

2. a) Explain why the synchronous motor is not self starting and explain damper winding method of starting of synchronous motor. [6]

   b) A 20 MVA, 3 phase star connected 11 KV, 12 pole 50Hz salient pole synchronous motor has a direct axis reactance of 50 ohm and quadrature axis reactance of 3 ohm per phase. The armture resistance being negligible. At rated load, unity power factor and rated voltage determine (i) excitation voltage (b) The maximum value of power angle and corresponding power. [6]

3. a) A 2/3 HP, 230 V, 50Hz, 6-pole single phase induction motor has following parameter: [7]

   R1 = 3.04 ohm, X1 = 6.2 ohm, X0 = 105.6 ohms, R0 = 85 ohms

   R_2' = 6.26 ohm, X_2' = 2.12 ohm. No-load loss = 122 watts.

   The motor is operating at 4% slip.

   Determine: (i) Motor speed (ii) Input current and power factor (iii) Output power

   b) Explain the operating principle of capacitors start and run single phase induction motor. [7]

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1 ½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is meant by armature reaction in synchronous generator? Discuss the effect of armature reaction on its emf when load is resistive, capacitive and inductive. [8]

   b) A 3-phase, star-connected, 60 KVA, 400V, 50 Hz alternator has effective resistance of 0.25 Ω/ph. The synchronous reactance is 3.5 Ω/ph and leakage reactance is 0.75 Ω/ph. Determine at rated load and 0.8 lagging P.F (i) the internal emf E_i, (ii) the value of armature reactance which represents armature reaction. [6]

2. a) How armature winding current and power factor of synchronous motor varies at different values of field excitation current. Explain it with neat diagram in detail. [8]

   b) "Power angle characteristics of non salient pole synchronous machine is not valid for salient pole synchronous machine". Justify the statement. [4]

3. a) What is double field revolving theory in single phase induction motor? Explain the operation of single phase induction motor through its equivalent circuit. [8]

   b) Explain the principle of operation of Single phase Reluctance motor. [6]

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25 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Why terminal voltage (V) of a synchronous generator is greater than internal generated emf (E) in case of capacitive load? Explain with the help of armature reaction and phasor diagram. [8]

   b) A 3-phase, 5kVA, 208V, 4-pole, 60 Hz, star connected synchronous generator has negligible armature winding resistance and synchronous reactance of 10 ohms per phase. The generator is first connected to an infinite bus of 208V, 60 Hz [6]

      i) Determine the excitation voltage and the power angle when the generator is delivering rated kVA at 0.8 pf lagging?

      ii) If the field excitation is now increased by 15% (keeping turbine power constant), find the stator current, power factor, active and reactive power constant.

2. a) Why three phase synchronous motor is not self starting? Explain the method of starting with damper winding. [6]

   b) A 3 phase, 10 MVA, 2300 V, 60 Hz synchronous motor has Xs = 0.9 pu and negligible stator resistance. The motor is connected to infinite bus. If terminal voltage, V_t = 2300 V<0 and excitation emf E_f=3450V<120. Determine power transfer and power factor of machine. Also draw phasor diagram. [6]

3. a) A single phase induction motor has R_1=2Ω, X_1=X_2^1=3.1Ω, R_2^1=1.98 Ω and X_{mag}=40.17 Ω. If the motor is supplied from 240 V signal phase ac supply, determine input current, power factor and torque developed by motor. [6]

   b) Explain any two: [4×2]

      i) Capacitor start motor
      ii) ac servo motor
      iii) Reluctance motor

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1½ hrs.

Subject: - Electric Machine II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the dark lamp method of synchronization of an alternator with already running alternator. [8]

   b) A 50 Hz, 3 Phase, 500 V, star connected synchronous generator with salient pole rotor has Xd = 0.1 Ohm and Xq = 0.075 ohm. Armature winding resistance is 0.1 ohm. The generator supplies 100A at 0.8 pf lagging. Calculate the excitation emf. [6]

2. a) Justify, Synchronous motor is not self starting. Explain any two starting methods of synchronous motor. [2+4]

   b) Explain power angle characteristics of cylindrical rotor machine. [6]

3. a) Discuss the procedure to determine the parameters of equivalent circuit of one phase induction motor. [8]

   b) Draw a neat diagram of a Schrage motor. Discuss its application. [6]

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12/23

25 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	40
Programme	BEL	Pass Marks	16
Year / Part	III / I	Time	1½ hrs.

Subject: - Electric Machines II *(EE601)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the conditions to be satisfied for parallel operation of two alternators? Describe the process of synchronization. **[8]**

   b) A 850 kVA, 380V,50Hz 3-phase alternator delivers 400kW to an 3-phase induction motor at a power factor of 0.8 lagging. Calculate the number of 100W lamps which can be added to the alternator so that the alternator does not overload beyond its capacity. **[6]**

2. a) Explain how a synchronous motor can be operate to draw lagging current as well as leading current with detailed diagram. **[8]**

   b) The full load current of 3.3 kVA, star-connected synchronous motor is 160A at 0.8pf lagging. The resistance and synchronous reactance of the motor are 0.8Ω and 5.5Ω per phase respectively. Calculate the excitation emf. Assume mechanical stray load loss to be 30KW. **[4]**

3. a) State and explain double field revolving theory of single phase induction motor with detailed diagram. **[8]**

   b) Explain operating principle of single stack stepper motor **[6]**

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