INDIAN MARITIME UNIVERSITY
(A Central University, Govt.of India)

May/June 2015 End Semester Examinations

SEMESTER – IV, B.TECH (MARINE ENGINEERING)

ELECTRICAL MACHINES - II (T 2404 / T 1404)

Date:16.06.2015 **Max.Marks:100**
Time:-3 Hrs **Pass Marks:50**

PART – A **(3 x10 = 30 Marks)**
(Compulsory Questions)

1. a) Define 'slip' and state the operating condition of induction machine when the slip is negative.

b) Explain any one methods of speed control of the three phase induction motors?

c) What are the different types of starters used for induction motors?

d) What are the applications of three-phase squirrel cage and slip ring induction motors?

e) What will happen if single-phasing occurs in a working 3-phase induction motor?

f) What is meant by fractional pitch winding and pitch factor?

g) What is meant by synchronous reactance?

h) Why saliency is required in rotor of synchronous machine?

i) Why synchronous motor is not self-starting?

j) What is synchronous condenser?

PART – B (5 x14 = 70 Marks)

(Answer any five of the following)

2. a) Show that in an induction motor, "Rotor input : mechanical power developed : rotor copper losses :: 1 : (1-s) : s", where s is the fractional slip. (7)

b) A three phase, 6-pole, 50 Hz star connected induction motor delivers useful power 25 kW while running at a speed of 950 rpm. It is connected to a supply of 400V (line to line) and takes a current of 60A. Its stator resistance per phase is 0.14 ohm. Mechanical losses are 900W.
Calculate (i) Shaft torque (ii) Electromagnetic torque (iii) Rotor copper loss
(iv) Stator copper loss (v) Stator iron loss and (vi) overall efficiency.
The power factor of the motor is 0.75 (lagging). (7)

3. a) If stator impedance of an induction motor is neglected, then show that $\frac{T_e}{T_{max}} = \frac{2}{\frac{s_{mt}}{s} + \frac{s}{s_{mt}}}$.

Where, T_{max} is maximum torque and S_{mt} is the slip at maximum torque. (6)

b) The output of a 3-phase, 50 Hz, 4-pole induction motor is 8 kW at 1400 rpm.
Calculate the starting torque if the maximum torque is developed at 1250 rpm.
Neglect stator resistance and mechanical losses. (8)

4. a) Explain with neat diagram of Auto-transformer starting of 3-phase induction motor. (6)

b) Design the five sections of a six stud rotor starter for a 3-phase slip-ring induction motor.
The full load slip is 2% and the maximum starting currents is limited twice the full-load current.
The rotor resistance per phase is 0.03 ohm. (8)

5. a) Classify the single-phase induction motors. Write down the working principle of a single phase motor. (3+4 = 7)

b) What is a universal motor? Explain the double revolving field theory. (2+5 = 7)

6. a) With a suitable 3-phase conductor diagram of a cross section of a stator(armature) of 3-phase synchronous machine and 3-phase current through them, describe how rotating magnetic field of two pole is produced in a 3-phase synchronous machine by 3-phase armature current. (8)

b) Derive an expression for emf generated per phase in 3-phase synchronous generator. (6)

7. a) With the help of schematic diagram, explain how a zero power factor lagging armature current has the effect of weakening the main field by the armature reaction in a 3-phase Synchronous Generator and also show that electromagnetic force/torque produced in rotor is zero. **(7)**

b) With the help of schematic diagram of a Synchronous Motor, explain how an unity power factor armature current has the cross magnetizing field effect by the armature reaction; also show that electromagnetic force/torque produced is in the direction motion of rotor. **(7)**

8. a) Derive an expression for winding distribution factor of a 3-phase Synchronous Generator. **(5)**

b) A 2300-V (between line to line), 1000-kVA, 0.8-PF lagging, 60-Hz, two-pole, Y-connected Synchronous Generator has a synchronous reactance of 1.1 Ω and an armature resistance of 0.15Ω. At 60 Hz, its friction and windage losses are 24 kW, and its core losses are 18 kW. Assume that the field current of the generator is adjusted to achieve rated voltage (2300 V) at full load conditions in each of the questions below.

i) What is the efficiency of the generator at rated load?

ii) What is the voltage regulation of the generator if it is loaded to rated kilo-volt-amperes with 0.8- Power Factor lagging loads? Also draw the voltage and current phasors.

iii) What is the voltage regulation of the generator if it is loaded to rated kilovolt-amperes with 0.8 power factor leading loads? Also draw the voltage and current phasors.

(3+3+3=9)

9. a) Discuss about the conditions necessary for paralleling of two three phase alternators. **(7)**

b) Using phasor diagram, derive an expression for 3-phase output power $\left(3VE\sin\delta/X_s\right)$ and torque $\left(3VE\sin\delta/\omega X_s\right)$ for synchronous generator loaded by a lagging power factor load current, where V=Terminal voltage per phase and E=No-load emf generated and δ is angle between them. **(7)**

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