Ref. No. : Ex/PE/T/223/2019

B.E. POWER ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION 2019

Subject : ELECTRICAL MACHINES - II

Time : 3 Hr. **Full Marks : 100**

Q1. Answer any five questions: 5×5

(a) Define pitch factor and breadth factor. Discuss the advantages of these factors.
(b) Generally cylindrical rotor construction is used for high speed machines and salient pole construction is used for low speed machines. Explain why?
(c) For a cylindrical rotor alternator working at lagging power factor, show that

$$\tan\delta = \frac{I_a\left(X_s\cos\theta - r_a\sin\theta\right)}{V_t + I_a\left(X_s\sin\theta + r_a\cos\theta\right)}$$

(d) Discuss the effect of change in excitation on power factor of synchronous motor.
(e) Derive the power angle characteristics of cylindrical rotor synchronous generator.
(f) Draw and explain the phasor diagram of synchronous motor operating at leading power factor.

Q2. Answer any one question: 12

(a) Derive the expression for synchronizing power and torque of a cylindrical rotor alternator?
A 5 MVA, 1000V, 1500 rpm, 3-phase, 50 Hz, alternator is operating on infinite bus bar. Find synchronizing power per mechanical degree of angular displacement at (i) no-load, (ii) full-load at rated voltage and 0.85 power factor lagging. Also find synchronizing torque for a 0.5 ° mechanical displacement in each case, Xs = 25%.
(b) (i) Derive swing equation and explain hunting in synchronous machine. State the effects of hunting. How can it be avoided?
(ii)Discuss any one starting method of synchronous motor.

Q3. Answer any one question: 16

(a) What is utilization factor? Find its value for open delta connection.
Two Scott connected transformers are used for transforming 6600 V, 3 phase to 400 V, 2 phase. The load on the main transformer secondary is 200 kVA at unity pf and the load on the other secondary is 300 kVA at unity pf. Neglecting losses, compute currents in transformer windings and in the primary supply lines. Draw phasor diagram.

(b) Draw the phasor diagram and circuit connections for Dd6,Yd11. Discuss six phase mesh connection or double delta connection with the help of suitable circuit and phasor diagram.
A bank of three single phase transformers is energized from 11 kV, 50 Hz source. If it takes 20 A from supply mains, then calculate the output voltage, output current, and output kVA for each of the following connections:
Star/star and delta/star
Per phase turns ratio is 10. Neglect magnetizing current and losses.

Q4. Answer any three questions: 3×12

(a) The open circuit characteristic of 1500 kVA, 11kV, 3 phase, star connected alternator has a resistance of 0.7 ohm per phase. The open circuit and zero power factor characteristics are as given below:

Field current(A)	40	50	110	140	180
Terminal voltage on open circuit (V, line value)	-	6650	11870	13250	14250
Terminal voltage at zero pf full load (V, line value)	0	-	-	-	11800

Draw the zero power factor characteristic. Find voltage regulation on full-load at 0.8 lagging power factor using ZPF method.

(b) A 1000 kVA, 6.6 kV, 50 Hz, star connected synchronous generator has no load voltage of 11.4 kV at certain field current. It gives rated terminal voltage at full load 0.75 lagging pf at the same field current.Calculate the synchronous reactance and the voltage regulation. The resistance is neglected. Draw the phasor diagram.

(c) A 1500 kVA, 3-phase star connected, 6.6 kV synchronous motor has the following data:

$$x_d = 23.2\Omega/\text{phase}, x_q = 14.5\Omega/\text{phase}$$

Armature resistance is neglected. Calculate the excitation emf when the motor is supplying rated load at 0.8 leading. Also draw the phasor diagram.

(d) A load of 30 kW at 0.8 pf lagging at 230 V is supplied by a transformer connected in open delta from 11 kV line.
(i) Determine the kVA rating of each transformer and their turns ratio.
(ii) Determine the h.v. and l.v. side line currents and the pf at which the transformers are operating. Also find out the active power supplied by each transformer.

(e) Primary, secondary and tertiary windings of a three phase three winding transformer are rated as 11 kV, 6 MVA star, 3.3 kV, 3 MVA star, 400V, 3 MVA delta. The short circuit test on this transformer gave following results:
Secondary shorted, primary excited: 500V, 100A
Tertiary shorted, primary excited: 600V, 100A
Tertiary shorted, secondary excited: 100V, 200A
Determine the resistances and leakage reactances of equivalent circuit of three winding transformer in p.u.

Q5. Answer any one question: 11

(a) Enumerate the disadvantages of current and voltage harmonics in transformers.
Explain the phenomenon of the oscillation of the neutral point.
Explain how harmonics can be suppressed in transformers.

(b) Discuss the phenomenon of sudden three phase short circuit of a synchronous generator. Draw the wave shape of short circuit current and identify different regions. Write the expression of the rms current at any time after short circuit has occured.
Draw the approximate equivalent circuit at the instant of short circuit and write down the expressions of corresponding reactances.