Ref. No. : Ex/PE/T/223/2018

B.E. POWER ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION 2018

Subject : ELECTRICAL MACHINES - II

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

Q1. Answer any six questions: 6×4

(a) Describe the advantages of providing field winding on the rotor and armature winding on the stator in case of large synchronous machines.
(b) Show that the armature reaction effect in an alternator, while supplying a leading power factor load, has a magnetizing effect.
(c) Define breadth factor. Derive the expression of the same for an AC machine.
(d) Draw and explain the phasor diagram of synchronous motor operating at lagging power factor
(e) Derive the power angle characteristics of salient pole synchronous generator.
(f) What are V-curves?
(g) What is synchronous condenser?

Q2. Answer any one question: 12

(a) What is synchronizing power?
A 5 MVA, 11 kV, 8 pole, 3-phase, 50 Hz, alternator having synchronous reactance of 0.5 pu is synchronized to 11 kV bus. Find synchronizing power per mechanical degree of angular displacement at (i) no-load, (ii) full-load at rated voltage and 0.8 power factor lagging. Also find synchronizing torque for a 0.4° mechanical displacement in each case.

(b) (i) State the conditions for connecting an alternator to a bus.
(ii) Discuss the auxiliary motor starting and induction motor staring methods of synchronous motor.

Q3. Answer any one question: 16

(a) Explain how a Scott connected transformer converts three phase power to two phase power using suitable connection diagram and phasor diagram.
A 110 V single phase furnaces take loads of 500 kW and 800 kW respectively at a power factor of 0.71 lagging and are supplied from 6600 V, 3 phase mains through a Scott connected transformer combination. Calculate the currents in three phase lines, neglecting transformer losses. Draw phasor diagram.

(b) Draw the phasor diagram and circuit connections for Yy0, Dy1. Discuss diametrical connection method of conversion from three phase to six phases with the help of suitable circuit and phasor diagram.
A three phase step down transformer is energized from 11 kV, 50 Hz source. If it takes 25 A from supply mains, then calculate the output voltage, output current, and output kVA for each of the following connections:
Star/delta and delta/delta
Per phase turns ratio is 44. Neglect magnetizing current and losses.

Q4. Answer any three questions: 3×12

(a) The open circuit characteristic of a 6-pole, 440 V, 50 Hz, star connected alternator is as given below:

Field current(A)	2	4	6	7	8	10	12	14
Terminal voltage on open circuit(V)	156	288	396	440	474	530	568	592

A field current of 7 A is needed to circulate the full load rated armature current of 40 A under short-circuit condition. The field current of rated terminal voltage under full-load zero power factor condition is 15 A. The armature resistance is 0.2 ohms per phase. Using Potier triangle method find regulation at full-load current of 40 A at 0.8 lagging power factor.

(b) A synchronous generator supplies rated power at 0.8 pf lagging. The resistance and synchronous reactance are 0.01 and 1 pu respectively. Calculate the possible terminal voltages if the excitation voltage is 2.01 pu

(c) A 1500 kW 3-phase star connected, 3.3 kV synchronous motor has the following data:

$$x_d = 4.01 \text{ pu}, x_q = 2.88 \text{ pu}$$

All losses may be neglected. If the motor is supplying rated load at unity pf, compute the power angle and the excitation emf. Also draw the phasor diagram.

(d) What is utilization factor? Find its value for open delta connection.
Two single phase transformers, each rated for 200 kVA, 11/0.4 kV, 50 Hz are connected in open delta.
(i) Determine the load kVA that can be delivered by this connection without overloading either transformer.
(ii) If this open delta connection is supplying a three phase balanced load of 200 kVA at 400 V, 0.866 pf lagging, then calculated the transformer currents on HV side and the ppf at which the transformer operates.

(e) A three phase 50 MVA, 50 Hz, 66/33/3.3 kV, star/star/delta transformer gave the following data for three short circuit tests:
Secondary shorted, primary excited: 4500V, 250A, 480 kW
Tertiary shorted, primary excited: 310V, 17A, 2.2 kW
Tertiary shorted, secondary excited: 160V, 35A, 2.2 kW
Determine the resistances and leakage reactances of equivalent circuit of three winding transformer.

Q5. Answer any one question: 12

(a) Explain how harmonics can be suppressed in transformers.
The exciting current of a single phase transformer at rated voltage and frequency is given by $i = 5\sin\omega t + 1.5\sin(3\omega t + \alpha_3) + 0.25\sin(5\omega t + \alpha_5)$

If three such transformers are connected with their primaries in delta and secondaries in star, then calculated rms value of (i) primary line current and (ii) current in primary delta

(b) What is an inrush phenomenon in transformers? Discuss qualitatively if a transformer is switched on at the instant when applied voltage is zero with positive slope. What is doubling effect? Sketch a typical oscillogram of inrush current and explain the shape.