Ref. No.: Ex/PE/T/424B/2018 (OLD)

B.E. POWER ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2018

ADVANCED TOPICS IN ELECTRICAL MACHINES

Time: Three hours | Full Marks: 100

Answer any five questions
All questions carry equal marks

1. Explain with diagram the generalized model of rotating electrical machines. Write down the voltage matrix of Kron's primitive machine. Hence, derive the expression of torque for the same.
A three-phase induction motor has the following per phase parameters referred to stator.
$r_1 = 0.5\ \Omega$, $r_2 = 0.45\ \Omega$, $x_1 = 2.5\ \Omega$, $x_2 = 2.5\ \Omega$, $x_0 = 50\ \Omega$.
Find the parameters of an equivalent two-phase motor if it's per phase turns are $\sqrt{3}/2$ times that of three-phase induction motor. 5+2+7+6

2. A 230 V separately excited dc motor, driving a constant load torque, has the following data:
Resistance of motor armature circuit = 0.4Ω; Inductance of motor circuit is 0.03Ω; Field resistance is 125Ω.
Motor torque constant is 2 Nm/armature amp; Inertia of rotating parts, J = 12.5 kg-m^2; Friction and windage is negligible; the armature current is 40 amps, with rated voltage across the armature and field.
Determine the magnitude of the constant load torque. If the armature voltage is suddenly reduced by 20volts, find the speed as a function of time. Derive the expression used. 20

3. (a) Deduce Park's transformations relating the 3-phase currents of a synchronous machine to its corresponding *d-q* axes currents. 12
(b) For steady state balanced operation with 8
$$i_\alpha = I_m \cos(\omega t + \varphi)$$
and $$i_\beta = I_m \sin(\omega t + \varphi)$$
Determine the primitive coil currents i_d and i_q and show that these are the steady state dc values.

4. Starting from the impedance matrix of a 3-phase salient pole synchronous machine without damper bars, derive voltage phasor equation under steady-state operation. Hence draw the phasor diagrams both for motor and generator. 12
From the phasor diagram of a salient pole synchronous motor at a leading pf, obtain the following relations:
(i) $\tan(\delta + \theta) = \dfrac{V_t \sin\theta + I_a X_q}{V_t \sin\theta - I_a R_a}$ and (ii) $E_f = V_t \cos\delta - I_q R_a + I_d X_d$ 8

5. (a) Discuss how the load test on Induction motor is performed. 5
(b) Describe the temperature rise tests of oil immersed transformers. 15

6. Why impulse testing of power transformer is necessary? Discuss, how surge voltage is generated from an impulse generator? Describe the general arrangement of equipments for an impulse test. 4+8+8

7. (a) What are the major sources of energy loss in power transformer? Describe different types of cooling systems used for power transformers. 5+10
(b) What is self-synchronization? 5