Ref No. EX/PG/PE/T/111B/31/2017

Master of Power Engineering 1st SEMESTER EXAMINATION 2017

Subject: Analysis of Electrical Machines

Use Separate Answersheet for each PART

Time: 3hrs **Full Marks: 100**

PART I

Answer any three Questions **Marks 30**

Q1.	Deduce the expression of short circuit current in case of a sudden three phase short circuit for an Induction Motor. State your assumptions.	10
Q2.	Derive the expression of torque from flux linkage and stator current in case of an universal field-oriented induction motor control. Enumerate your considerations.	10
Q3.	What is rotor field oriented I-Type Control? Draw the block diagram and identify the blocks.	10
Q4.	Derive the expressions for d axis and q axis currents in case of Electromechanical Transients for an Induction Motor?	10
Q5.	What tests were used for determination of operational impedences of solid rotor turbogenerators? Explain the tests.	10
Q6.	Write short notes (Any Two)	5 X 2 = 10

1. Inductances of Three Phase Induction Motors
2. Rotor field oriented V-Type Control
3. Constant airgap flux performance for field oriented control
4. Constant stator flux performance for field oriented control

MASTER OF POWER ENGG. EXAMINATION, 2017

(1st Semester)

ANALYSIS OF ELECTRICAL MACHINES

Part - II

*Answer any **four** questions*

(Two marks for neatness)

Full Marks: 70

1. Discuss the salient features of Kron's primitive machine? 5
   Draw basic two pole machine representation of DC shunt motor with interpoles, synchronous machine with damoer bars and induction motor. 3
   Obtain an expression for electrical torque of Kron's primitive machine. 6
   Show that no torque is produced by interaction of flux and current on the same axis. 3

2. Obtain identical transformations for currents from a rotating balanced 2-phase (α, β) winding to a pseudo-stationary 2-phase (d,q) winding. Show that the power invariance is maintained under this transformation. 10
   For steady state balanced operation with 7
   $$i_\alpha = I_m \cos(\omega t + \varphi)$$
   $$i_\beta = I_m \sin(\omega t + \varphi)$$
   Determine the primitive coil currents i_d and i_q and show that these are steady dc values.

3. Derive the expressions for armature self and mutual inductances of salient pole synchronous machine from consideration of its basic parameters. 9
   A two pole 3-phase 50 Hz star connected uniform air-gap synchronous machine has the following data: Armature winding - synchronous inductance = 0.02H per phase, Resistance is negligible; Field winding - self inductance = 35 H, resistance = 22 Ω; Mutual inductance between field winding and any one of armature winding, when their magnetic axes are aligned = 0.53 H.
   This synchronous generator delivers power to a balanced load at 0.8 pf lagging and at rated speed. Field winding is energized from 200 V dc source. If the terminal voltage across the load terminals is 900 V per phase, compute the power output. 8

4. A 3-phase 11 kV, 125MVA, star connected turbo alternator has the following pu constants.
   $$X_d = 1.2,\ X_d' = 0.3,\ T_d' = 1s, X_d'' = 0.15, T_d'' = 0.3s$$
   This alternator is operating at no-load with its rated terminal voltage. Now a sudden short-circuit occurs across its terminals; armature transformer voltages are neglected .
   (i) Find the current in phase a as a function of time. Assume that the short has occurred when phase a is 120° away from field axis.
   (ii) Write an equation for the envelope of short circuit current wave as a function of time.
   (iii) Find the rms value of symmetrical short circuit current in phase a, just after the three phase short circuit.
   (iv) If the transformer voltages are considered, then find maximum possible magnitude of dc component just after the short circuit. 17

5. Starting from impedance matrix of a 3-phase salient pole synchronous machine without damper bars, derive the voltage equation under steady state operation. Draw the phasor diagrams both for generator and motor. 17

6. Write short notes on (any two) 17

   (i) Park's transformation
   (ii) Negative sequence impedance and zero sequence impedance
   (iii) Voltage equations of Kron's primitive machine