BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/EIE, 1st Semester 2011-12
Course Title – Electromechanical Energy Conversion(EEE C 371/INSTR C371)
Comprehensive Examination—Date-12/01/2012
Full Marks – 60 (Weightage30 %) Duration—3 hours ----

---

(1)A 1500 kilowatts, 3-phase, star-connected 400 Volts (L-L), 50 Hz non–salient pole synchronous motor has a synchronous impedance of 0.4+j 4.0 ohms/phase. The motor has full load efficiency of 93% at input power factor of 0.866. Calculate exctation emf (E_f) and total mechanical power developed (using E_f) in equivalent kilowatts ----[7 Marks]

(2) A 11.0 kv(L-L) , 50 Hz. , star-connected 3-phase salient pole synchronous generator has a direct –axis reactance of 0.6 per unit/phase and a quadrature axis reactance of 0.10 per unit/ per phase, the armature winding resistance being negligible.It is delivering rated KVA at power factor =0.8 (lag) . Calculate excitation e.m.f (in per unit). [7 Marks]

(3) Consider a three phase non-salient pole synchronous motor (with armature winding resistance being neglected) with active power input being unchanged , even though the d.c field excitation is controlled/varied. Under such case , draw the locus of the tip of the "E_f-phasor". Show this locus with the help of phasor diagrams. Assume that armature supply (input)voltage remains fixed. Derive the necessary mathematical equations also.----[7 Marks]

(4) A 400 Volts (L-L) , (stator winding being star connected), 4-pole, 7.5 kw, 50 Hz., 3-phase induction motor develops its full load torque at a slip of 4.0%. The per phase equivalent circuit parameters are: R_1 =1.08 ohm , $X_1 = X_2'$ =1.41 ohm . Calculate the value of rotor winding resistance per phase (referred to stator). Mechanical losses, core losses and stray losses may be neglected. .-------[7 Marks]

(5) Derive the condition such that the efficiency of a single phase transformer (at a given load voltage and output power factor) becomes maximum. Detailed analysis should be presented. .-------[8 Marks]

(6) Explain **"armature reaction"** phenomenon of a D.C Machine with necessary constructional diagram and m.m.f/flux waveforms (in space).Your explanation /waveforms should also include the concepts of **"magnetic neutral axis" and". geometric neutral axis" and expressions for ampere –conductors/pole and ampere-turns per pole .** What are the effects of "armature reaction" on the machine (any two)? .-------[7+1 Marks]

[P.T.O]

(7) Derive the expression for Electromagnetic torque of a three phase induction motor either applying Thevenin's Theorem on its equivalent circuit or by any other method using approximate equivalent circuit. The analysis presented should be in detail (with all steps). Also draw the torque-slip characteristic (labeled). .-------[6+2 Marks]

(8) An ideal transformer has a primary winding of 200 turns. On the secondary side, the number of turns between A and C is 1000. B is the mid -point tapping of this secondary winding (AC). The transformer supplies a resistor connected between B and C , which draws 10.0 kw. Further a load of 2000(0.707 + j 0.707) ohm is connected between A and B . The primary voltage is 2.0 kv. Find the magnitude of the primary current.
-------[8 marks]

END

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/EIE, 1st Semester 2011-12
Course Title – Electromechanical Energy Conversion(EEE C 371/INSTR C371)
TestII (OPEN BOOK)—Date-22/12/2011
Full Marks – 20 (Weightage10 %) Duration—50 min.
Instruction: Only Text Book and hand written notes are allowed.

---

(1)A 1500 kilowatts, 3-phase, star-connected 2300 Volts (L-L), 50 Hz non–salient pole synchronous motor has a synchronous reactance of 2.0 ohms/phase. The motor is supplied from a three phase, star- connected , 2300 volts (L-L) non salient pole synchronous generator whose synchronous reactance is 2.8 ohms/phase. When the motor is drawing full load power at input power factor=1.0, calculate : (a) The excitation e.m.f of the generator (b) The excitation e.m.f of the motor . (c) Maximum power (active power) flow from the generator to the motor with machine excitations held fixed . Assume that the motor has no power loss and also the armature winding resistance is zero (both for motor and generator). ---------[3+2+3 Marks]

(2) A 440 volts(L-L) , 50 Hz. , star-connected 3-phase salient pole synchronous generator has a direct –axis reactance of 0.12 ohm/phase and a quadrature axis reactance of 0.075 ohm per phase, the armature winding resistance being negligible. I_a =1000.00 Amp, power factor =0.8 (lag) . Calculate excitation e.m.f [6 Marks]

(3) Consider the equivalent circuit of a non-salient pole synchronous generator (with R_a being taken into consideration) and based on this circuit , prove that (in per phase basis), P_m (in)- P_e (out) =$(I_a)^2$ R_a . The symbols have their usual meanings. Lagging or any other power factor may be assumed for the said mathematical proof. Step-by-step analysis (in detail) should be presented.-------[6 Marks]

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/EIE, 1st Semester 2011-12
Course Title – Electromechanical Energy Conversion(EEE C 371/INSTR C371)
Test 1—Date-03/11/2011
Full Marks – 30 (Weight age15 %) Duration—50 min.

---

(1)A 20 KVA, 2000/200 volts, two-winding transformer is to be used as an autotransformer with a constant source voltage of 2000 volts. At full load and unity power factor, calculate (as autotransformer): (a) Power output in kilowatts (b) Power transformed (inductively coupled) in kilowatts (c) Power conducted (conductively coupled) in kilowatts. (d) If the efficiency of the two-winding transformer at full load and at power factor=0.7, is 97%, calculate the efficiency of the autotransformer at full load and at same power factor.
Assume that total losses remain same in both the configurations.---------[2+2+2+4 Marks]

(2) (a) Drawing necessary equivalent circuit and phasor diagram of a single phase transformer, starting from fundamentals, prove that (at lagging power factor load):

%Voltage Regulation = (%R) Cos φ +(%X) Sin φ , where the symbols have their usual meanings. The analysis should be presented in detail. .---------[1+1+4 Marks]

(b)Draw the connection diagram for **Vector Group Dy11** for three phase transformer, showing logical steps. Given voltage phase sequence: R-Y-B (c.c.w) or Ph A-Ph B- Ph C (c.c.w) .-----[4 Marks]

(3) Explain the basic model and ARMATURE REACTION of a three phase non-salient pole synchronous machine with necessary diagrams ,waveforms, phasor diagrams and equations, under Generator or Motor mode. .---------[5+1+1+1+2 Marks]

BITS, Pilani – Dubai
International Academic City – Dubai **[Set—B]**
III year EEE/EIE, 1st Semester 2011-12
Course Title – Electromechanical Energy Conversion(EEE C 371/INSTR C371)
Quiz 2 (Set—B)
Full Marks – 10 (Weight age 5 %) Duration—20 min.
Date: 14-12-2011

Name---------- Id No.----------

Marks distribution: Questions (1)and (4)---3 Marks each and rest – 2 mark each

(1) Why do you get SCC (Short Circuit Characteristic) of a three phase cylindrical rotor synchronous generator to be a straight line ?-----Explain with the help of necessary equations/phasor diagram.(With $R_a = 0$ or very small)

(2) A three phase non salient pole star connected synchronous motor has the following data:
I_a =238.09 Amp., E_f =3600Volts(L-L), X_s =5.0 ohms/phase, R_a =0, δ =33.74 degree (elect.)----------Calculate input power factor of the motor.

(3) Machine---3 phase Synchronous , Type—Non-salient pole , Mode –Generator Nature of Armature Reaction---Partly Magnetising, Partly Cross-magnetising----- ---------- Draw the combined space & time phasor diagram for such specifications .

[P.T.O]

(4) Draw the equivalent circuit of a three phase non salient pole synchronous generator, with labeling.

(5) In relation to Question (4), write down the voltage balance equation.

----------END----------

Name /Id No. _ _ _ _ _ _ _ _

BITS, Pilani – Dubai
International Academic City – Dubai **[Set—A]**
III year EEE/EIE, 1st Semester 2011-12

Course Title – Electromechanical Energy Conversion(EEE C 371/INSTR C371)
Quiz 1 (Set—A)
Full Marks – 10 (Weight age 5 %) Duration—20 min.
Date: 05-10-2011

Name---------- Id No.----------

Marks distribution: Questions (1)and (2)---3 Marks each and rest – 2 mark each

(1)A single phase 15.0 KVA transformer has a load voltage of 220 volts at full load . Maximum efficiency occurs at a load current=I amps. Iron loss=150 watts and R_{eq}=0.07 ohm. Calculate the value of "I" as a percentage of full load current.

(2)In a single phase transformer (equivalent circuit), $\bar{I}_0$ =0.693-j1.33 Amp. and $\bar{I}_2'$ =8.66-j5.0 Amp.. Calculate $\bar{I}_1$ in polar complex form.

(3) Why does the equivalent circuit of a transformer involve a shunt branch element?----Answer in brief.

(4) A single phase transformer is on no-load. Which will be the correct value of the resistance offered by the load (loading rheostat —for example) to the transformer?:
(a) Zero (b) Infinity (c) Neither "zero" nor "infinity"