BITS, PILANI – DUBAI, ACADEMIC CITY, DUBAI
FIRST SEMESTER 2010 – 2011
EEE C371/ INSTR C371 ELECTRO MECHANICAL ENERGY CONVERSION
COMPREHENSIVE EXAMINATION (CLOSED BOOK)

MAXIMUM MARKS: 60 **WEIGHTAGE: 30%**
DATE: 30 /12/10 **DURATION: 3 HOURS**

Write PART A & B in separate answer sheets

Answer all questions

PART A

(1) (i) Derive emf equation for a dc generator. **[3 Marks]**

(ii) A 20Kw 250V dc shunt generator has armature resistance and field resistance of 0.1 Ω and 125 Ω. Calculate total armature power developed when running as
(a) Generator (b) motor **[7 Marks]**

(2) (i) Derive the condition for Maximum efficiency of a transformer. **[3 Marks]**

(ii) A 100KVA distribution transformer supplying light and fan loads has full load copper loss and core loss of 1.5 and 2KW respectively. During 24 hours in a day the transformer is loaded as follows

6AM to 10AM - Half load

10AM to 6PM – One fourth load

6 PM to 10 PM – Full load

10 PM to 6 AM – No load

Calculate all day efficiency of the transformer. **[7 Marks]**

(3) (i) The iron loss in a transformer is 80 W at 25 Hz and 204W at 60 Hz having same magnetic flux density. Calculate the total iron loss at 100 Hz at the same magnetic flux density. **[5 Marks]**

(ii) A 4 pole 500V shunt motor has a total of 720 armature conductors which are wave connected. The full load armature current is 60A and the flux per pole is 0.03 Webers. The armature resistance is 0.2Ω. The voltage drop across each brush is 1 volt. Calculate the full load speed of the motor. **[5 Marks]**

P.T.O.

PART B

(4) (i) Derive the expression for Electromagnetic torque of a three phase induction motor using Thevenin's theorem OR using any other method, starting from the concept of its equivalent circuit. **[5 Marks]**

(ii) A 3.3 Kv , 20-pole, 50-Hz, 3-phase, star connected induction motor has a slip-ring rotor of resistance of 0.025 ohm per phase and standstill reactance of 0.28 ohm per phase (both referred to stator).The motor has a speed of 294 rpm when full load torque is applied. Calculate: (a) slip at maximum torque (ii) the ratio of maximum torque to full load torque. Neglect stator impedance and the effects of the shunt branch of the equivalent circuit. **[5 Marks]**

(5) (i) Derive the expression for active power as a function of torque angle (P-δ equation or power transfer equation) of a three phase salient pole synchronous machine (as a Generator or Motor) , starting from fundamentals based on the phasor diagram (under any load power factor). Neglect the armature winding resistance. **[5 Marks]**

(ii) A three phase 50 Hz. salient pole synchronous generator has direct and quadrature axes steady state armature winding synchronous reactances (X_d and Xq) as 0.58 p.u per phase and 0.5 p.u. per phase, respectively. The terminal voltage per phase is 1.0 p.u and armature winding current per phase is 1.0 p.u at 0.8 power factor (lag). Neglect armature winding resistance. Calculate excitation emf (E_f) per phase and load angle (δ) after drawing the phasor diagram with proper labeling. **[5 Marks]**

(6) (i) Explain any three methods of speed control of three phase induction motor ,with relevant circuit diagrams/block diagram /necessary equations. **[5 Marks]**

(ii) Explain, in brief "Armature Reaction" of three phase non salient pole synchronous generator with necessary diagrams/equations and develop its equivalent circuit. **[5 Marks]**

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TEST II (OPEN BOOK)

MAXIMUM MARKS: 20 **WEIGHTAGE: 10%**
DATE: 15/ 12/10 **DURATION: 50 MINUTES**

Instructions: Only Text Book and handwritten class notes are allowed.

1. 1000 KVA, 6.6 kv(line-to-line), three phase star-connected Synchronous Generator has a synchronous reactance of 20 ohms per phase. It supplies full-load current at 0.85 power factor (lagging) and at the rated terminal voltage. Calculate the excitation e.m.f (line-to-line) and torque angle. Armature winding resistance is ignored. **[7marks]**

2..A three phase slip-ring type induction motor has 4-pole star connected stator winding and runs on 50 Hz with 400 volts between lines. The rotor resistance per phase and rotor standstill leakage reactance per phase is 0.5 ohm and 3.8 ohm, respectively. The effective ratio of rotor winding to stator winding number of turns per phase is 0.67. Neglect stator impedance. Calculate: (a) Electromagnetic torque (gross torque) at 4% slip (b) Gross mechanical power at 4% slip.
[6 marks]

3. The power input to a 500V, 50 Hz 6 pole 3 phase induction motor running at 975 rpm is 40 KW. The stator losses are 1KW and friction and windage losses total 2KW. Calculate (a) the Slip (b) the rotor copper loss (c) the output horse power (d) efficiency. **[7marks]**

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EEE C371/ INSTR C371 ELECTRO MECHANICAL ENERGY CONVERSION
TEST 1(CLOSED BOOK)

MAXIMUM MARKS: 20 **WEIGHTAGE: 10%**
DATE: 28/10/10 **DURATION: 50 MINUTES**

1. A transformer has its maximum efficiency of 0.98 at 20 KVA at unity power factor. During the day it is loaded as follows
   12 hours : 2KW at p.f = 0.6
   6 hours : 10 Kw at pf =0.8
   6 hours : 20 Kw at pf =0.9
   Find the All day efficiency of the transformer. **[5 marks]**

2. A 20KVA, 4400/220V transformer with an equivalent impedance of 0.02 ohm is to operate in parallel with a 15 KVA, 4400V/220V transformer with an equivalent impedance of 0.028 ohm. The two transformers are connected in parallel and made to carry a load of 25 KVA. Assume both the impedance to have the same angle
   (i) Find the individual load currents **[5 marks]**

3. A 3 phase step down transformer is connected to 6600V on primary side. The turns ratio N1/N2 = 12 and line current drawn from mains is 20A. Find the secondary line voltage current if transformer is connected in
   (i) Y-Y (ii) Delta –Delta (iii) Y- Delta (IV) Delta – Y
   [5 marks]

4. (i) Draw the equivalent circuit of the synchronous generator with neat phasor diagram. **[3 marks]**
   (ii) List out the different types of the alternator
   (ii) To change the voltage and frequency of the alternator, explain which parameters has to be altered.
   [1+1 marks]

BITS, Pilani-Dubai

Course Title: ELECTROMECHANICAL ENERGY CONVERSION

1st Semester, 2010-11

Name of the student/Id No.----------/----------

Quiz-II (F.M-10, Weightage—5%)

IIIrd Year (EEE/EIE)

Set B

(1) Draw the equivalent circuit of a three phase non salient pole synchronous generator (with labeling). [1 mark]

(2) Draw the phasor diagram of a three phase salient pole synchronous generator (with labeling) under lagging power factor [1 mark]

(3) Draw the equivalent circuit of the 3 –phase induction motor. [3 marks]

(4) Voltage regulation of the synchronous generator is negative when _____ [1 mark]

(5) A 4 pole, 50 Hz synchronous machine runs at _____rpm((synchronous speed) [1 mark]

(6) "With reference to a three phase induction motor, larger is the air-gap length lesser is the value of no-load current."--- Is statement "TRUE" or "FALSE"? ---------- [1 mark]

(7) Write the expressions for the "Slip for maximum torque" and "Maximum torque" of a three phase induction motor. Assume that R_1 =0 and X_1 =0 and effects of shunt branch parameters of the equivalent circuit are ignored. - [2 mark]

Answers:

BITS, PILANI – DUBAI
FIRST SEMESTER 2010 – 2011
EEE C371 ELECTROMECHANICAL ENERGY CONVERSION
QUIZ 1 (CLOSED BOOK)

MAXIMUM MARKS: 10 **WEIGHTAGE: 5%**
DATE: 13/10/2010 **DURATION: 20 MINUTES**

NAME:	ID NO:

(1) If a transformer is lightly loaded(25% of full load) then also the condition $N_1I_1 = N_2I_2$ will be satisfied (or, fulfilled) (the symbols having their usual meanings).------"TRUE" or "FALSE" ? **[1Mark]**

(2) Derive the condition for Maximum Efficiency in transformer **[3 Marks]**

(3) Draw the phasor diagram of transformer at lagging power factor on load.
[1 Mark]

(4) In the case of two single phase identical transformers connected through the method of Scott Connection, the output voltage of TEASER transformer and that of MAIN transformer will have a phase angle difference between themselves (in degree)(in time frame) of ----------

[1 Mark]

(5) A transformer has maximum efficiency of 98 % at 15 KVA output at power factor=0.8(lag). Its iron(core) loss in kilowatts will be: **[2 Marks]**

(6) With reference to Question(5) , the transformer has full load output of 20 KVA at power factor =0.8(lag). Its half -load copper loss in kilowatts will be ----------

[2 Marks]