BITS,Pilani-Dubai

2012-13,1st Semester/IIIrd year(EEE & EIE)/Comprehensive Exam.

Course Title/Code: Electromechanical Energy Conversion(EEE C371/INSTR C371)

Max.marks---60(weightage—30%)/Date—06/01/2013—Duration—3 hours.

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(1)A three phase, 50 Hz., slip-ring type induction motor has a 4-pole, star connected stator winding and runs on 400 volts(L-L). The rotor has its own resistance(per phase) and leakage reactance(per phase) of 0.5 ohm and 3.8 ohm , respectively-. The effective ratio of rotor winding number of turns per phase to stator winding number of turns per phase is 0.67. Neglect stator impedance. Use approximate equivalent circuit.

Calculate:----(a) The electromagnetic torque at 4.0% slip (b) The gross mechanical power(approximate shaft output power) at 4% slip; (c) Slip for maximum torque; (d) Maximum electromagnetic torque.-------[8 marks]

(2) A 3-phase, non-salient pole, star- connected Synchronous generator having a synchronous reactance(per phase) of 1.0 p.u is connected to load at 1.0 p.u voltage(per phase) through two parallel lines , each of 0.5 p.u reactance(per phase). Calculate the generator excitation e.m.f per phase (magnitude , in p.u) when it delivers rated current(1.0 p.u) at unity power factor at its armature terminals (not at load ends). Assume : R_a =0 .------[7 marks]

(3) A 175 kw, 400 volts, 4-pole D.C Generator has 720 conductors for WAVE winding. Brush shift = 3.0 (mechanical) degrees of GNA. Calculate the Cross magnetizing and Demagnertising ampere-turns per pole. [5 marks]

(4)Based on the "Double revolving field theory", and based on the concepts of "Slip with respect to forward rotating magnetic field" and "Slip with respect to backward rotating magnetic field", develop the equivalent circuit of a Single phase Induction Motor (without "auxiliary / starting" winding) ---------[P.T.O]

and derive the expression for the input current of that equivalent circuit .----[2+1+2+2 marks]

(5) A 100 KVA distribution transformer supplying light and fan loads, has full load copper loss and core loss of 1.5 kw and 2.0 kw , respectively. During 24 hours in a day, the transformer is loaded as follows:

6 A.M to 10 A.M---Half(1/2) load , 0.8 p.f(lag); 10 A.M to 6 P.M---One-

fourth (1/4) load , unity p.f; 6—10 P.M----Full load, 0.8 p.f (lag)

10 P.M to 6 A.M---No load. ---------Calculate all day efficiency .------[8 marks]

(6)(a) Derive the condition for a transformer to have its efficiency to be maximum.----------[5 marks]

(b) Explain ,in steps how the "VECTOR GROUP" of a three phase transformer can be determined (any example to be shown with diagrams).-----[5 marks]

(7)A three phase, 50 Hz, salient pole synchronous generator has X_d =0.58 p.u per hase and X_q =0.5 p.u per phase. The terminal voltage(per phase) is 1.0 p.u at 0.8 power factor(lag). Calculate excitation e.m.f (E_f) per phase , in p.u. and load angle or torque angle (δ) in degrees, after drawing the phasor diagram with proper labeling. Assume that R_a=0 and per phase armature current is 1.0 p.u----[6 marks]

(8) (a) A 15.0 kw, 400 volts, star connected, non-salient pole Synchronous motor of 90% efficiency ,has a synchronous impedance of 0.4 +j4.0 Ω per phase. Input power factor is o.866 (lead). Find the excitation e.m.f(L-L).

(b) With reference to the speed control of 3-phase induction motor, explain (with necessary diagrams and equations) the "V/f Control" OR "any other two methods".----[4+5 marks]

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/EIE, I Semester 2012-13
Course Title – Electromechanical Energy Conversion (EEE C371/INSTR C371)
TEST-2 (OPEN BOOK)
Full Marks – 20 (Weightage 10%) Duration—50 min
Date: 09---12—2012

Instructions: Text book and handwritten class notes are only allowed

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(1) A 2500 volts (L-L), three phase star connected non salient pole synchronous motor has a synchronous reactance of 5.0 ohms per phase. Armature winding resistance is neglected. The motor input power is 1000 KW at rated voltage and an excitation e.m.f of 3600 volts (L-L).Calculate the armature current and input power factor.-------[7 marks]

(2) Develop the phasor diagram of a salient pole synchronous machine("generator" or " motor " mode) , on the basis of terminal conditions (when d-axis and q-axis are not known initially). The terminal conditions mean armature current, (load current or, input current) , voltage (terminal voltage or input supply voltage) and power factor(load p.f or input p.f). X_d and X_q are also known parameters. Derive the necessary equations for development of that phasor diagram. The necessary reasoning also should be explained. Assume any power factor (lag or lead or unity p.f). Detail labeling of the phasor diagram is also needed. Armature winding resistance is neglected.----------[6 marks]

(3) A three phase star connected salient pole synchronous generator has: X_d = 9.6 Ω/phase, X_q = 6.0 Ω/phase, V_t= 6.6 kv(L-L), R_a = 0, load of 2.5 mega-watts(MW) (for three phases) at 0.8 power factor(lag). Calculate the percentage voltage regulation.---[7 marks]

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/EIE, I Semester 2012-13
Course Title – Electromechanical Energy Conversion (EEE C371/INSTR C371)
TEST-1
Full Marks – 30 (Weightage 15 %) Duration—50 min
Date: 16---10—2012

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(1) A transformer has its maximum efficiency of 0.98 at 20 KVA (output) at unity power factor. During the day, it is loaded as follows:
12 Hours: 2.0 kw at power factor=0.6
6 Hours: 10.0 kw at power factor=0.8
6 Hours: 20.0 kw at power factor=0.9.
Find the "ALL DAY EFFICIENCY" of the transformer.----------[10 marks]

(2) Consider that in any electrical rotating machine, three windings (coils) distributed in space by 120° (electrical)(between each pair of windings) angle, are energized from three phase balanced A.C Source . Each winding has number of turns =N. Derive the expression for the resultant m.m.f-field , starting from fundamentals. Use the typical (established) expression for m.m.f(Pulsating Field m.m.f) of each phase winding. What is the standard name of this Resultant Field?----------[13 marks]

(3) Two single phase transformers(of equal voltage ratio) are working in parallel. Draw the approximate equivalent circuit (model) for such two transformers in parallel and hence write down(derive) the necessary(all) mathematical equations related to LOAD SHARING.
[7 Marks]

BITS,Pilani-Dubai [SET-A]

2012-13/1st Semester/Quiz-2/ III yr/EEE & EIE

Course Title/No.-Electromechanical Energy Conversion/ (EEE C371/INSTR C371)

Date of Exam.—19/11/2012--Duration-20 min--Max.Marks—10(weightage—5%)

Instructions: Geometrical constructions needed not to scale

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

(1)Based on no load and blocked rotor test results, a circle diagram of a three phase Induction Motor can be drawn. Based on this locus, how will you find the operating point on the locus corresponding to rated output of the motor? Show the concerned geometrical diagram(locus) and the steps of finding that operating point.----------[1+2 marks]

(2)For a three phase Induction Motor, if rotor input power(air-gap power)= P_g ,then how will you find electromagnetic torque?----Derive the expression. Write the meanings of the symbols associated with the process of derivation. ----------[2 marks]

(3) With reference to the circle diagram in question(1), how will you construct the " TORQUE LINE"? Explain with the help of a separate diagram.--------[2 marks]

[P.T.O]

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

(4) Express the armature reaction process of a three phase non-salient pole synchronous machine through a suitable equation (in terms of m.m.f or flux or induced e.m.f) and define each symbol used. .--------[1 mark]

(5) A three phase non salient pole synchronous machine has the following data:

No. of poles(P)=4 ; Mean air gap diameter(D)=0.16 m ; Stator core length =rotor core length(L)=0.12 m . Calculate the cross sectional area of the flux path (per pole). .------[2 marks]

BITS,Pilani-Dubai [SET-B]

2012-13/1st Semester/Quiz-1/ III yr/EEE & EIE

Course Title/No.-Electromechanical Energy Conversion/ (EEE C371/INSTR C371)

Date of Exam.—05/11/2012---------Max.Marks—10(weightage—5%)

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

(1)Two single phase transformers (equal voltage ratio) , working in parallel , have $\frac{Z_1}{Z_2} = k$. With the symbols having their usual meanings, "S_1/ S_2" equals to:

(a) k (b) 1/k (c) k^2 (d) k+1 ----------[1 mark]

(2)Two single phase furnaces, A and B, are supplied at 100 volts by means of a Scott-connected transformer combination from a 3-phase 6600 volts(line-to-line) system. N_p and N_s are the number of turns of primary(source side) and secondary (load side)widings, respectively of the TEASER TRANSFORMER. Calculate the value of the ratio "N_p / N_s".----------[2 marks]

(3) *"A three phase non-salient pole type Synchronous Machine has non uniform radial air-gap length throughout the armature periphery"*---------TRUE or FALSE ? ----------[1 mark]

(4) Armature m.m.f of a three phase synchronous machine leads to the development of :-

(i) A pulsating magnetic field (ii) A rotating magnetic field (iii) A uniform and stationary magnetic field ----------[1 mark]

[P.T.O]

[SET-B] Name/Id No.----------

(5) Draw a neat connection diagram(labeled) of Scott connection of two single phase transformers (indicating number of turns of primary and secondary windings of each transformer) and also draw the voltage phasor diagrams of input side and load side, separately.

------[1+1marks]

(6) In a three phase salient pole type Synchronous Machine, armature winding inductances (per phase) along direct and quadrature axes are L_d and L_q , respectively. Assuming the area of cross-section of the flux paths along the two axes , to be same, find which of the following options is correct :--

(a) $L_d = L_q$ (b) $L_d < L_q$ (c) $L_d > L_q$

Also derive the concerned equations, in support of your answer.----------[1+2 marks]