(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2021 Roll No. | | | | | | | | | | |

002612

B.Tech.

FOURTH SEMESTER EXAMINATION, 2004-2005

ELECTRO-MECHANICAL ENERGY CONVERSION-I

Time : 3 Hours *Total Marks : 100*

Note : *(i) Attempt ALL questions.*

(ii) All questions carry equal marks.

(iii) In case of numerical problems assume data wherever not provided.

1. Attempt *any four* parts of the following : (5x4=20)

(a) Differentiate magnetic circuits and electric circuits.

(b) A cast steel ring has a circular cross-section of 3 cm in diameter and a mean circumference of 80 cm. A 1 mm air-gap is cut out in the ring which is wound with a coil of 600 turns. Estimate the current required to establish a flux of 0.75 mWb in the air-gap. Neglect leakage.

Magnetization data :

H (AT/m)	200	400	600	800	1000	1200	1400	1600	1800
B(T)	0.10	0.32	0.60	0.90	1.08	1.18	1.27	1.32	1.36

(c) The flux in a magnetic core is alternating sinusoidally at a frequency of 600 Hz. The maximum flux density is 2 Tesla and the eddy-current loss is 15 watts. Find the eddy current loss in the core if the frequency is raised to 800 Hz and the maximum flux density is reduced to 1.5 Tesla.

(d) Explain the term 'co-energy' in Electromechanical energy conversion and show that coenergy is given by :

$$W_f' = \frac{1}{2} P.F.^2$$

Where P = permeance of the magnetic circuit

F = mmf in coil of magnetic circuit

(e) The magnetic flux density on the surface of an iro face is 1.6 Tesla which is a typical saturation leve value for ferromagnetic material. Find the force density on the iron face.

(f) For Doubly-excite Magnetic field system, variou inductance are : $L_{11} = (4 + \cos 2\theta) \times 10^{-3}$ H $L_{12} = 0.15\cos\theta$ H, $L_{22} = (20 + 5\cos 2\theta)$ H. Find th torque developed if $i_1 = 1$ Amp and $i_2 = 0.02$ Am Also explain the significance of each terms in torqu

2. Attempt *any two* parts of the following : (10x2=2(

(a) A dc shunt generator has the following open-circu characteristic when separately excited :

Field Current, (Amp)	0.2	0.4	0.6	0.8	1.0	1.4	2.(
Emf (Volts)	80	135	178	198	210	228	24

The shunt winding has 1000 turns per pole and total resistance of 240 ohm. Find the turns p pc of a series winding that will be needed to m t terminal voltage the same at 50 Amp output as no-load. The resistance of the armature windi including the series compounding winding, can assumed to be 0.40 ohm and constant. Ign armature reaction.

(b) A 220 V dc series motor has the following data :

$Z = 180$, $P/A = 1$, Flux/Pole = 3.75 mWb/field amp., total armature circuit resistance = 1 ohm.

The motor is coupled to centrifugal pump whose load torque is $T_L = 10^{-4} n^2$ N – m; where n = speed in rpm. Calculate the current drawn by the motor and the speed at which it will run.

(c) A 20 kW, 500 V dc shunt motor has an efficiency of 90% at a full load. The armature copper loss is 40% of the full load loss. The field resistance is 250 ohm. Calculate the resistance values of a 4-section starter for this motor in given two cases :

(i) starting current $\leq 2I_{fl}$.

(ii) Starting current(min) = 120% I_{fl}.

3. Attempt *any two* parts of the following : (10x2=20)

(a) Explain the series-parallel control of dc shunt motor. Hopkinson's test on two machines gave the following results for full load; line voltage 250 volt, line current excluding field current 50 A; motor armature current 380 Amp; field currents 5 Amp and 4.2 Amp. Calculate the efficiency of each machine. The armature resistance of each machine = 0.02 ohm.

(b) (i) A 440 V, 4-pole, 25 kW dc generator has a wave-connected armature winding with 846 conductors. The mean flux density in the air-gap under the interpoles is 0.5 Wb/m^2 on full load and the radial gap length is 0.4 cm. Calculate the number of turns required on each interpole.

(ii) Derive the condition for zero voltage regulation. Also show that the magnitude of maximum voltage regulation equals the p.u. (per unit) value of equivalent leakage impedance.

(c) A single phase load is fed through a 66 kV feeder whose impedance is (120 + j400) ohm and a 66/6.6 kV transformer whose equivalent impedance (referred to LV) is (0.4 + j1.5) ohm. The load is 250 kW at 0.8 leading power factor and 6 kV.

(i) Calculate the voltage at the sending-end of the feeder

(ii) Calculate the voltage at primary terminals of the transformer

(iii) Calculate the complex power input at the sending-end of the feeder.

4. Attempt *any two* parts of the following : (10x2=20)

(a) An audio-frequency ideal transformer is employed to couple a 60 ohm resistance load to an electric source which is represented by a constant voltage of 6 volt in series with an internal resistance of 2400 ohm.

(i) Determine the turn-ratio required to ensure maximum power transfer by matching the load and source impedance.

(ii) Find the load current, voltage and power under the conditions of maximum power transfer.

(b) What do you understand by the term 'vector group' of a transformer ? Show the terminal connections of a 3-phase transformer having vector groups.

(i) DY1L

(ii) Dd6 and the corresponding phasar diagrams.

(c) Two single-phase transformers, rated 1000 KVA and 500 KVA respectively, are connected in parallel on both HV and LV sides. They have equal voltage ratings of 11 KV/400 V and their per unit impedances are $(0.02 + j0.07)$ and $(0.025 + j0.0875)$ ohms respectively. What is the largest value of the unity power factor load that can be delivered by the parallel combination at the rated voltage ?

5. Attempt *any two* parts of the following : **(10x2=20)**

(a) A 500-KVA, 11/0.43 KV, 3-phase delta/star connected transformer has on rated load an HV copper-loss of 2.5 kW and an LV loss of 2 kW. The total leakage reactance of 0.06 per unit. Find the ohmic values of the equivalent resistance and leakage reactance on the delta side.

(b) Explain the Scott connection for phase conversion in transformer. Also give applications of it.

(c) (i) Enumerate the purposes of tertiary winding in transformers.

(ii) A 400/100 V, 10 KVA, 2 winding transformer is to be employed as an autotransformer to supply a 400 V circuit from 500 V source. When tested as a 2-winding transformer at rated load, 0.8 = pf lagging, its efficiency is 0.97. Determine its KVA rating and efficiency as an auto-transformer.

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