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SE-6807

B. E. III (Sem. V) (Electrical) Examination

April / May – 2011

Electrical Machine - III

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ B. E. 3 (Sem. 5) (Electrical)

Name of the Subject :

☛ Electrical Machine - 3

☛ Subject Code No. : 6 8 0 7 ☛ Section No. (1, 2,.....) : 1&2

Seat No. :

Student's Signature

(2) Attempt all question.

(3) Answer to the two sections must be written in separate answer books.

(4) Figures to the right indicates full marks.

(5) Assume necessary data wherever required.

(6) Scientific calculator up to Casio-100D, 100MS series is permitted.

SECTION - I

1 (a) Fill in the following blanks : **6**

(1) A relationship between hystersis loss and flux density B_{max} is given by _____.

(2) A coil of 1000 turns is wound on a core. A current of 1A flowing through the coil creates a core flux of 1mwb. The energy stored in the magnetic field is _____ joule.

(3) Silicon steel when used for transformer core reduce _____ loss.

(4) Ferromagnetic materials lose their _____ properties at a _____ known as curie point.

(5) The coefficient of coupling of two coils is proportional to _____.

(b) Compare electromagnetic and permanent magnetic material. **4**

(c) Define field energy and co-energy. What is the significance of co-energy ? **4**

(d) The magnetic circuit consists of ring of magnetic material and a single air gap g=0.3cm, in a stack of height D=2.5cm. The ring have inner radius $R_i = 4\,cm$ and outer radius $R_0 = 5\,cm$. Assume that the magnetic material with infinite permeability, and neglect the effects of magnetic leakage and fringing. For N=100 turns, calculate **6**

(i) The mean core length l_c and the core cross-sectional area Ac.

(ii) The reluctance of the core R_c and that of the gap R_g.

(iii) Inductance L.

(iv) Current i required to operate at an air gap flux density of $B_g = 1.2\,T$.

(v) The corresponding flux linkage of the coil.

2 (a) The core made of cold-rolled silicon steel (B-H curve) is shown in **Fig. 1**. It has a uniform cross-section of 5.9 cm^2 and a mean length of 30 cm. Coils A, B and C carry 0.4, 0.8 and 1 A respectively in the shown direction. Coils A and B have 250 and 500 turns respectively. How many turns coil C have to establish a flux of 1 mwb in the core? **7**

H(KAT/m)	0.05	0.1	0.2	0.3	0.5	1	2
B(T)	1	1.35	1.45	1.63	1.69	1.78	1.86

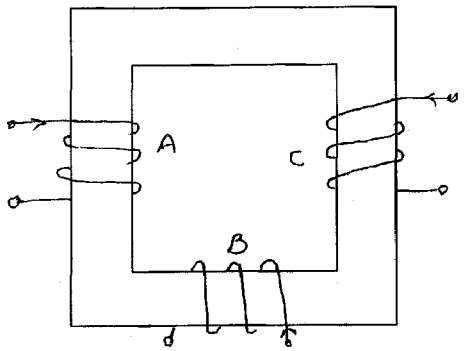

Fig. 1

(b) Starting from energy balance equation determine an expression for force in a multiple-excited magnetic field transducer as a function of flux, inductance and current parameters. 8

OR

2 (a) The magnetic circuit shown in **fig. 2**. The movable element is constrained to motion such that the lengths of both air gaps remain equal. 8

(i) Find the self-inductances of windings 1 and 2 in terms of the core dimensions and the number of turns.

(ii) Find the mutual inductance between the two windings.

(iii) Calculate the co-energy $W'_{fld}(i_1, i_2)$.

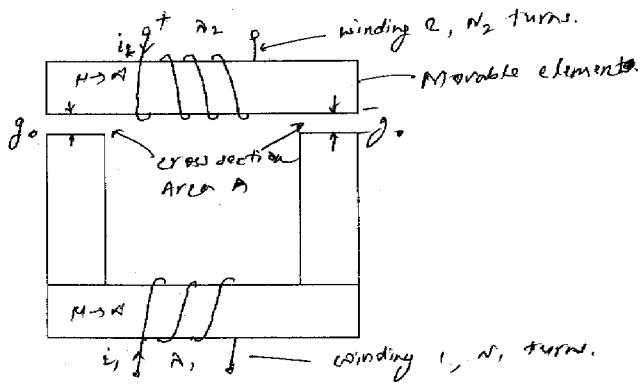

Fig. 2

(b) Derive the expression for force and torque in system with permanent magnets. 7

3 (a) Derive an expression for voltage induced in distributed winding of AC machine. 8

(b) For the magnetic circuit of **Fig. 3**. Find the self and mutual inductances between the two coils. Core has permeability = 1800. Assume current in winding is 1A. 7

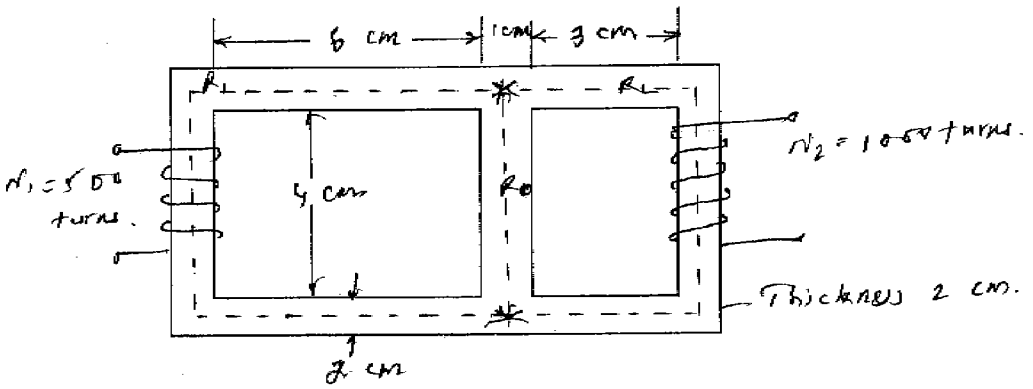

Fig. 3

OR

3 (a) Develop mmf wave for a 12 slot, 2 pole armature of DC machine carrying 2 coil side in each slot. 6

(b) **Figure 4** shows the magnetic circuit for a permanent magnet loudspeaker. The voice coil (not shown) is un the form of a circular cylindrical coil which fits in the air gap. A neodymium-iron-boron magnet is used to create the air gap dc magnetic field which interacts with the voice coil currents to produce the motion of the voice coil. The designer has determined that the air gap must have length g=0.2 cm and height h=1 cm. 9

Assuming that the yolk and pole piece are of infinite magnetic permeability $(\mu \to 0)$. Find the magnet height d and the magnet radius R that will result in the air-gap magnetic flux density of 1.2 T and require the smallest magnet volume.

For neodymium-iron-boron at maximum energy product.

Bm=0.64T, Hm=–425 K AT/m.

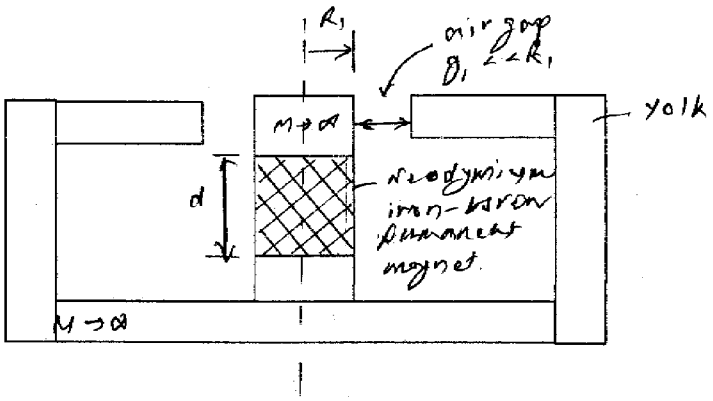

Fig. 4

SECTION - II

4 (a) Fill in the blanks : **10**

(1) Numerically controlled machine uses _____ motor.

(2) In multistack variable reluctance steeping motor having 'n' stacks in series, the stator or rotor on each stack is displaced by _____ times the pole pitch angle.

(3) In hysteresis motor, torque angle δ depends on _____ of the rotor and independent of _____.

(4) Series universal motor runs at around _____ to _____ rpm.

(5) For slip s=0.05, and operating frequency of 60 Hz, the frequency f_b of emfs and currents set up by backward field is ____.

(6) The torque developed by a single phase induction motor at synchronous speed is _____.

(7) The direction of rotation of a single phase split-phase induction motor is reversed by interchanging the terminals of both windings. Is it true ?

(8) Magnetic axis of stator rotates from _____ part to _____ part in shaded pole induction motor.

(9) Vacuum cleaner uses _____ type of motor.

(10) Single phase induction motor never touches _____ speed.

(b) A 4/2 VRM has following dimensions : **7**

R = 4 cm

$\alpha = \beta = 45^{o}$

air gap = 2.6×10^{-2} cm

D=0.15 m and the phase windings are connected in series such the there are a total of N = 100 turns (50 turns per pole) in each phase winding. Assume the rotor and stator to be of infinite magnetic permeability. Draw cut view of motor showing all details.

(a) Neglecting leakage and fringing fluxes, plot the phase-1 inductance $L(\theta)$ as a function of θ.

(b) Plot the torque, assuming (i) $i_1 = I_1$ and $i_2 = 0$ and (ii) $i_1 = 0$ and $i_2 = I_2$.

(c) Calculate the net torque acting on the rotor when both windings are excited such that $i_1 = i_2 = 5A$ and at angles (i) $\theta = 0^{o}$, (ii) $\theta = 30^{o}$, (iii) $\theta = 60^{o}C$.

(c) Explain double revolving field theory in connection with single phase induction motor. **3**

5 (a) A 220 V, single-phase induction motor has the following test results : 8

No-load test : 220 V, 5 A, 325 W

Locked-rotor test : 125 V, 14 A, 580 W

The stator winding resistance is $1.5\,\Omega$ measured with direct current. Estimate the power factor, output, efficiency for slip of 4%.

(b) A permanent magnet dc motor has armature resistance $1.05\,\Omega$. When operated at no load from a dc source of 48 V, it is observed to operate at speed of 2100 rpm and draw a current of 1.75 A. 7

Find

(i) Torque constant Km

(ii) No load rotational losses of motor

(iii) Power output of the motor when it is operating at 1550 rpm from a 36 V source.

OR

(b) A 185W, 220V, 50Hz capacitor start motor has the following constants for the main and auxiliary windings at starting : 7

$$Zm = 8.5 + j7.5\,\Omega$$
$$Za = Ra - j25.4\,\Omega$$

Find the value of starting resistance that will place the main and auxiliary winding currents in quadrature at starting. Also find the current drawn by the motor. Enlist applications of such type of motors.

6 Attempt any **three** : **15**

(1) Explain how performance will be affected by three different brush positions in the repulsion motor.

(2) Suggest modifications required in design of AC series motor.

(3) The ratio of a.c. speed to d.c. speed equals to power factor of ac series motor. Explain with help speed-torque characteristic of it.

(4) Derive an expression for maximum starting torque with capacitor start motor with the help of complex diagram.

(5) Draw and explain the equivalent circuit of single phase induction motor.
