

W 2681

M.E. DEGREE EXAMINATION, JANUARY 2007.

First Semester

Power Electronics and Drives

PE 1601 — MODELLING AND ANALYSIS OF ELECTRICAL MACHINES

(Regulation 2005)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

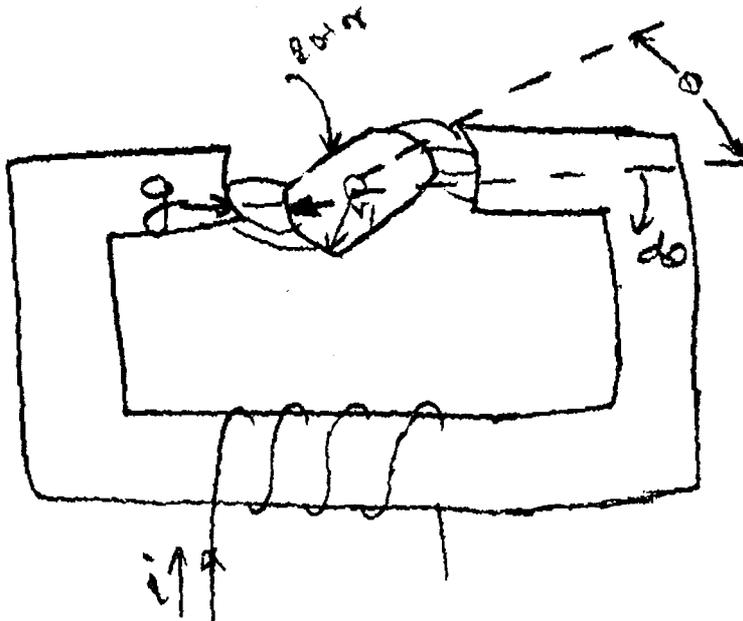
PART A — (10 × 2 = 20 marks)

1. Define and give the relation for magnetic pressure.
2. Represent graphically energy and co-energy.
3. A dc motor is started directly from a 220 V dc supply with no load. Find its starting speed response and the time taken to reach 100 rad/ms.
4. List various parameters of a synchronous machine.
5. What do you mean by rotor balancing?
6. Write any two assumptions taken to apply generalized theory for synchronous machine.
7. List the restrictions of the generalized theory of machines.
8. What is Park's and Clark's transformations?
9. Mention the applications of DC transmission systems.
10. Explain the words ON-Line and OFF-line with respects to UPS.

PART B — (5 × 16 = 80 marks)

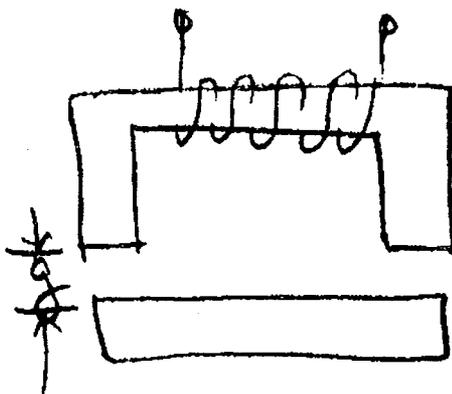
11. (a) The magnetic circuit shown in Fig. 11(i) is made of cast steel. The rotor is free to turn about a vertical axis. The dimensions are shown on the figure.
 - (i) Derive an expression in SI units for the torques acting on the rotor in terms of the dimensions and the magnetic field in the two air gaps. Neglect the effects of fringing. (10)

- (ii) The maximum flux density in the overlapping portions of the air gags is limited to approximately 2 Tesla, because of saturation in the steel. Compute the maximum torques in Newton-meters for $r_1 = 2$ cm, $h = 2$ cm and $g = 0.2$ cm. (6)



Or

- (b) The lifting magnetic system shown in Fig. 11 (ii) has a square cross section 6×6 cm². The coil has 300 turns and a resistance of 6 ohms. Neglect reluctance of the magnetic core and field fringing in the air gap.
- (i) The air gap is initially held at 5 mm and a dc source of 120V is connected to the coil. Determine: the stored energy and the lifting force. (8)
- (ii) The air gap is again held 5 mm and an ac source 120 V(rms) at 50 Hz is connected to the coil. Determine the average value of the lift force. (8)



(a) (i) Explain the steps involved in the computation of dc motor response and other quantities of interest with the help of a flow chart. (8)

(ii) A series excited dc machine designed for a variable-speed application has the following name-plate details and parameters :

3 hp, 230 V, 2000 rpm; $R_a = 1.5 \Omega$, $R_{se} = 0.7 \Omega$, $L_a = 0.12 \text{ H}$,
 $L_{se} = 0.03 \text{ H}$, $B_1 = 0.0025 \text{ N-m/(rad/sec)}$.

Calculate: the input voltage required in steady state to deliver rated torque at rated speed and the efficiency at this operating point. Assume that a variable voltage source is available for this machine.

(8)

Or

(b) (i) Draw the equivalent circuit for a poly phase induction motor and derive an expression for the air gap power in terms of rotor resistance (8)

(ii) Discuss the various operational impedances for a synchronous machine with four rotor windings. (8)

13. (a) (i) Explain how Park's transformation transforms equations in a,b,c variable to d,q,0 variable. (8)

(ii) Obtain the equivalent circuit of three phase synchronous machine with reference frame fixed in rotor. (8)

Or

(b) (i) Describe the formulation of transformation of 3 phase variables to a stationary reference frame (10)

(ii) Deduce the expression for power in stationary reference frame (6)

14. (a) With relevant expressions, explain the simulation of a three phase fault at the terminals of a synchronous machine using Park's transformation. (16)

Or

(b) Derive the expression for electromagnetic torque in machine variables for a 2 phase, 2 pole synchronous machine. (16)

15. (a) Model the typical PM brushless DC motor for a trapezoidal flux distribution. (16)

Or

- (b) Write short notes on: (4 × 4)

- (i) Phase advancing
 - (ii) Commutation-torque ripple
 - (iii) Interior permanent magnet machine
 - (iv) Motor inductance on dynamic performance
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