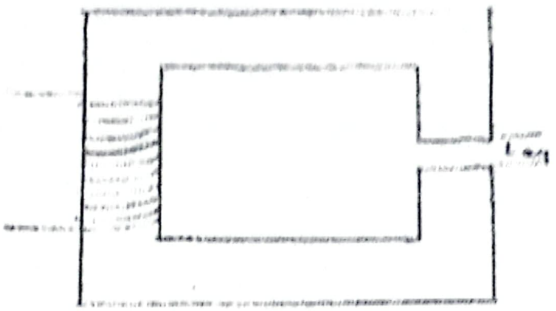
QUESTION ONE (Compulsory)

(a) Explain two methods of speed control in dc motor. **[4 Marks]**

(b) A magnetic circuit with N = 200 turns, Core cross-sectional area, A = 0.1 m^2, Total core length, L = 50 cm, Air gap length = 0.5 cm and B in air gap 0.8 T. Assume Core $\mathcal{R}$ is negligible: Find H_{air}, Φ, $\mathcal{R}_{air}$ and $\#_{turns}$. **[4 Marks]**



Silicon Iron (1%)

(a) Define Armature reaction and state two effects on the distribution of the main magnetic field. **[3 Marks]**

(b) With neat diagram explain main parts of DC machine. Mention functions of each part. **[6 Marks]**

(c) List three areas of shunt generator application. **[3 Marks]**

(d) A 220 V shunt motor has the following parameters: Ra = 0.6 Ω, RF = 100 Ω and rotational (core, mechanical and stray) losses are 50 W. On full load, the line current is 19.5 A and the motor runs at 1200 rpm, find:

i. The developed power. **[4 Marks]**

ii. The output power. **[3 Marks]**

iii. The output torque. **[3 Marks]**

QUESTION TWO

(a) Derive an expression for the e.m.f generated in a DC generator. **[3 Marks]**

(b) A magnetic flux of 0.0046 Wb passes through a core cross sectional dimensions of 10 cm x 17 cm. Find the flux density. **[2 Marks]**

(c) A shunt machine, connected to a 200V main has an armature resistance of 0.15 Ω and field resistance is 100 Ω. Find the ratio of its speed as a generator to its speed as a motor, line current in each case being 75 A. **[5 Marks]**

(d) Explain principle of operation of DC generator. **[4 Marks]**

(e) Explain Magnetic Permeability and Relative Permeability [2 Marks]

(f) A magnetic core made of cast steel must carry a flux density of 1.0 T. It has a total length of 1.56 M and a cross-sectional area of 0.37 m^2. Find the permeability, the relative permeability and reluctance of the core. Given; $\mathbf{B}$ = 1.0 T and $\mathbf{H}$ = 800 A-t/m. [4 Marks]

QUESTION THREE

(a) State Faraday's law of Electromagnetic induction. [1 Mark]

(b) Using a well labelled schematic diagram, explain the working principle of long shunt compound D.C generator. [4 Marks]

(c) A 4-pole, wave-connected armature has 400 conductors and is driven at 500 rev/min. If the flux per pole is 10 mWb, determine the generated e.m.f. [5 marks]

(d) A Determine the terminal voltage of a generator which develops an e.m.f. of 200 V and has an armature current of 30 A on load. Assume the armature resistance is 0.30Ω. [5 Marks]

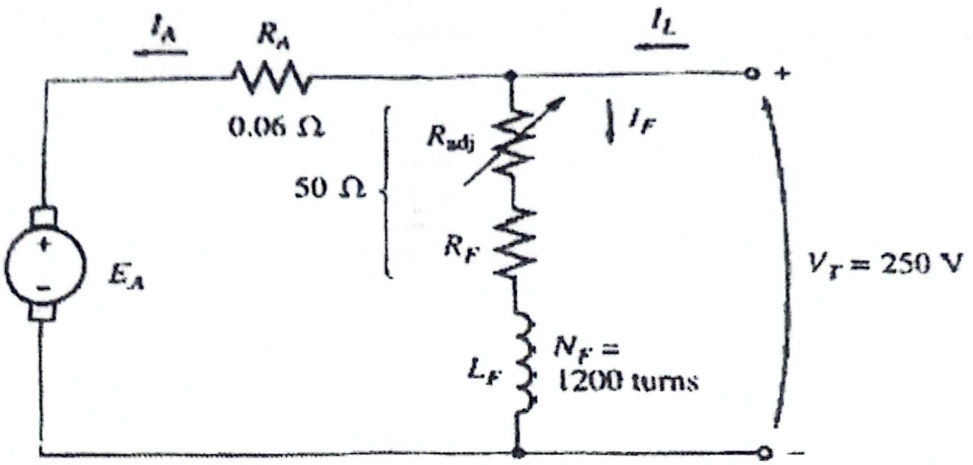
(e) A lap wound DC shunt generator having 80 slots with 10 conductors per slot generates at no load emf of 400 volt, when running at 1000 r. p.m., at what speed should be rotated to generate a voltage of 220 volt on open circuit. [5 Marks]

QUESTION FOUR

(a) List four applications of Series DC motor. [2 Marks]

(b) Derive the Torque Equation of DC Motor. [5 Marks]

(c) A 50 hp, 250 V, 1200 rpm dc shunt motor with compensating winding has an armature resistance (including the brushes, compensating windings, and interpoles) of 0.06 Ω. Its filed circuit has a total resistance $R_{adj}+R_f$ of 50Ω, which produces a no-load speed of 1200 rpm. There are 1200 turns per pole on the shunt field winding.



i. Find the speed of this motor when its input current is 100 A. **[5 Marks]**

(d) A 4-pole dc shunt generator with lap-connected armature supplies a load of 100 A at 200 V. The armature resistance is 0.1Ω and the shunt field resistance is 80 Ω. Find

i. total armature current, **[2 Marks]**

ii. current per armature path, **[3 Marks]**

iii. E.m.f generated. Assume a brush contact drop of 2V. **[3 Marks]**

JESTION FIVE

a) Enumerate four types of DC Motors and its application. **[4 Marks]**

b) A 10 kW shunt generator having an armature circuit resistance of 0.75Ωand a field resistance of 125Ω generates a terminal voltage of 250 V at full load. Determine the efficiency of the generator at full load, assuming the iron, friction and windage losses amount to 600 W. **[5 Marks]**

c) State types of losses in a D.C machines. **[2 Marks]**

d) Using a sketch, explain T_a/I_a characteristic of DC shunt motor. **[4 Marks]**

e) With a well labelled diagram, explain the working principle of a series DC motor. **[5 marks]**