



Notes:(Total Mark : 70 , No. of questions: 3)

- Answer the following questions in the same order and assuming any missing data.
- Drawing should be cleared and well organized

Question 1: [30 Marks]

- A. **Discuss** with the aid of diagrams the construction , operation of the **Fuel cell** and its application
- B. **Draw** a schamatic diagram showing a Hydro electric power station . **Illustrate** the construction and operation of the power station.
- C. The magnetic circuit shown in figure (1) of has dimensions $A_c = 4 * 4 \text{ Cm}^2$, $L_g = 0.06 \text{ cm}$, $L_c = 40 \text{ cm}$; $N = 600$ turns Assume the value of $\mu_r = 6000$ for iron. Find :
- The exciting current for $B_c = 1.2 \text{ T}$
 - The corresponding flux

(Take fringing in considration)

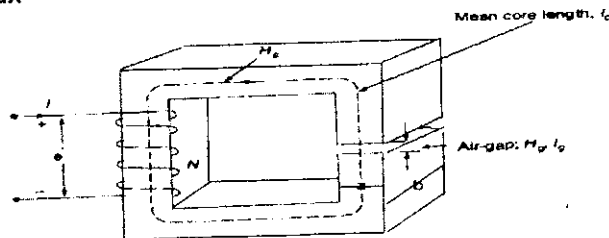
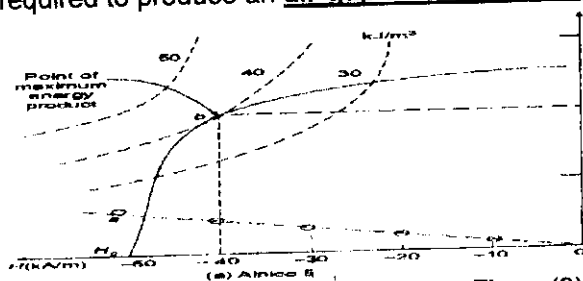
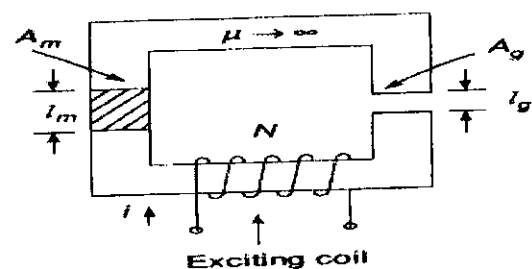


Figure (1)

- D. The magnetic circuit shown in the Figure (2) consists of a core of very high permeability ($\mu_r = \infty$) and an air-gap length of $L_g = 0.4 \text{ cm}$ and $A_g = 3.0 \text{ cm}^2$. **Find the minimum permanent magnet volume required to produce an air-gap flux density of 0.7 T.**



Figure(2)



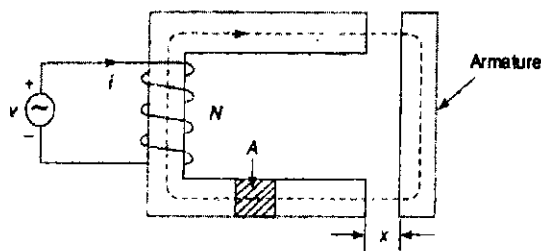
Question 2: [25 Marks]

- A. In the electromagnetic relay shown in figure (3) the exciting coil has 1000 turns. The cross sectional area of the core is $A = 5 \text{ cm} * 5 \text{ cm}$. Reluctance of the magnetic circuit may be assumed negligible. Also neglect fringing effects.
1. **Find the coil inductance** for an air-gap of $x = 1 \text{ cm}$
 2. **Calculate the field energy** when the coil carries a current of 2.0.
 3. **Derive an expression for force** on armature as a function of x and With constant coil current of 2.0 A. **Find the work done** by the magnetic field when x changes from $X_a = 1 \text{ cm}$ to $X_b = 0.5 \text{ cm}$.
 4. **Find the force on the armature** as a function of λ . if the current and flux linkages are related as:

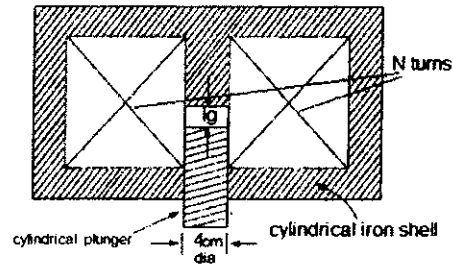
$$[i = \lambda^2 + 2 \lambda(1-x)^2 \quad x < 1]$$
- B. The Figure (4) shows the cross-sectional view of a cylindrical iron solenoid magnet. The plunger which has been made of iron is restricted by stops to move through a limited range

The exciting coil has 1500 turns and carries a steady current of 3 A. **Assume that** all reluctance offered only by the air-gap L_g and Magnetic leakage and fringing to be neglected.

1. Find the **air-gap flux densities, coil inductance and energy stored in the magnetic field for air-gap lengths of 2.0 , 1.5 cm.**
2. if the plunger is allowed to **move slowly** from $l_g = 2.0$ cm to $l_g = 1.5$ cm Find :
 - i. **Mechanical work done.**
 - ii. **Electrical energy supplied by the source,** neglect the coil resistance



Figure(3)



Figure(4)

- C. The flux in a magnetic core is alternating sinusoidal at a frequency of 600 Hz. The maximum flux density is 2 T and the eddy current loss is 15 W. 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

Question 3:[15 Marks]

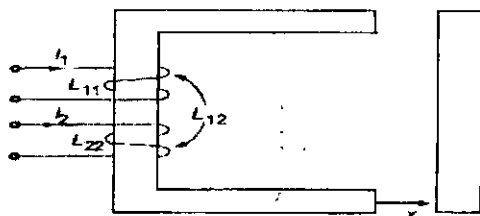
- A. The two coils of the magnetic circuit shown in figure(5) have self- and mutual-inductances as follow:

$$L_{11}=L_{22}=4+\frac{1}{2X}$$

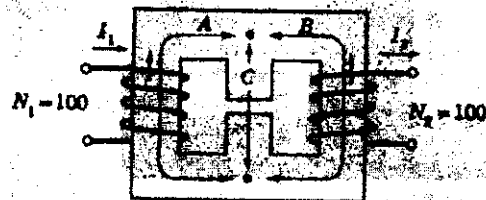
$$L_{12}=L_{21}=\frac{1}{2X}$$

Calculate coil currents and the time-average force at $x = 0.5$ m when:

- Both the coils connected in series across a voltage source of $100 \cos 314t$
- Both the coils connected in Parallel across a voltage source of $100 \cos 314t$
- Coil 2 is shorted while coil 1 is connected across a voltage source of $100 \cos 314t$



Figure(5)



Figure(6)

- B. The coils of the magnetic circuit shown in figure (6) are connected in series so that the mmf's of paths A and B both tend to set up flux in the center leg C in the same direction. Neglect fringing and leakage . ($\mu_r = 2000$), (Cross section area of A and B Legs = 12 cm^2 and Leg C = 24 cm^2) and (Length A and B path= 15 cm and C path= 5 cm and air gap = 0.4 cm) .
- The current require in each coils to set up a flux density of 0.6 Tesla.
 - The self-inductance for each coils and Mutual inductance.

This exam measures the following ILOs			
Skills	Knowledge & Understanding Skills	Intellectual Skills	Professional Skills
Question Number	Q1A , Q1B, Q2C, Q1D	Q1C, Q2B, Q1B	Q2A , Q3B

With Best Wishes

Dr.Dina shaban