BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FIRST YEAR FIRST SEMESTER EXAM, 2024

PRINCIPLES OF ELECTRICAL ENGINEERING - I

Time: Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

	PART I **Answer any three questions.** **Two marks are reserved for neat and well organized answers.**	**Marks**
1.a)	Deduce the capacitance per unit length between two co-axial cylinders with the assumption that +Q Coulomb of charge is on the outer surface of the inner cylinder and the outer cylinder is earthed.	6
1.b)	Derive an expression for potential energy in an electric field.	5
1.c)	It is required to hold four equal point charges +Q in equilibrium at the corners of a square of 2 m side. Find the point charge that will do this if placed at the centre of the square. The square is placed in air.	5
2.a)	State and prove Gauss's law.	5
2.b)	Deduce an expression for force of attraction between two oppositely charged plates.	5
2.c)	An air capacitor consisting of 2 parallel plates of 50-cm side is charged to p.d. of 250 V when the plates are 1 mm apart. Find the work done in separating the plates from 1 to 3 mm. Assume perfect insulation.	6
3.a)	State and explain Biot Savart's law.	3
3.b)	Deduce expressions for the magnetic field intensity and magnetic flux density on the axis of a square coil and hence show that the magnetic field intensity at the centre of a square coil is $\sqrt{2}I/\pi a$, where 'I' is the current flowing through the coil and 'a' is half the length of any side of the square coil.	8

3.c)	The magnetic field due to a current carrying circular loop of radius 12 cm at its centre is 0.5×10^{-4} T. Find the magnetic field due to this loop at a point on the axis at a distance of 5 cm from the centre.	5
4.a)	Deduce an expression for magnetic field strength at a point due to a finite length of wire carrying current.	5
4.b)	Deduce an expression for the coefficient of coupling for two magnetically coupled coils.	5
4.c)	Two coils, X of 12000 turns and Y of 15000 turns, lie in parallel planes so that 45% of the flux produced by coil X links coil Y. A current of 5 A in X produces 0.05 mWb while the same current in Y produces 0.075 mWb. Calculate (a) the mutual inductance, and (b) the coupling coefficient.	6
5.a)	Derive an expression for the energy stored in a magnetic field.	4
5.b)	Deduce an expression for the eddy current loss occurring in a magnetic material.	6
5.c)	Two coils, with terminals AB and CD respectively, are inductively coupled. The inductance measured between terminals AB is 380 μH and that between terminals CD is 640 μH. With B joined to C, the inductance measured between terminals AD is 1600 μH. Calculate: (a) the mutual inductance of the coils; and (b) the inductance between terminals AC when B is connected to D.	6

Ref.No. Ex/EE/5/T/111/2024

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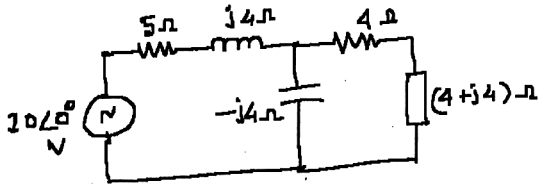
Time: 3 hours Use Separate Answer script for each part Full Marks:100

Part-II (50 Marks)
ANSWER ANY THREE QUESTIONS
QUESTION NO.1 CARRIES 18 MARKS

Q.1. (A) State the Maximum power transfer theorem applicable for both the AC and DC circuits.
(B) Apply the Thevenin's theorem to determine the value of current through 4Ω resistor-



6+12=18

Q.2. (A) A coil of resistance 50Ω and inductance 0.25H is in parallel with a circuit having 55Ω resistor and 100 μF capacitor. The parallel circuit is connected to a 230V, 50Hz supply. Calculate (i) the supply current; (ii) the equivalent circuit impedance, resistance and reactance.
(B) A voltage, given by

$$v(t) = 50 \sin \omega t + 15 \sin(3\omega t + \pi/5)$$

is applied to a circuit containing a resistance of 20Ω in series with an inductor of 0.05H with negligible resistance. If the fundamental frequency is 50 Hz, calculate (i) the power dissipated (ii) the power factor for the circuit.

8+8=16

Q.3. (A) State and explain the Superposition theorem applicable for an electrical circuit.
(B) State and prove the Millman's theorem for number of voltage sources connected in parallel.

6+10=16

Q.4. (A) A 5μF capacitor, initially charged to 230V, is discharged through a 200kΩ resistor. What is the capacitor voltage at 0.20s after the capacitor starts to discharge?
(B) Show that the energy $W_L(t)$ stored in an inductor 'L' is expressed by -

$$W_L = \frac{L}{2}[i_L^2(t_1) - i_L^2(t_0)]$$

where $i_L(t_1)$ and $i_L(t_0)$ are the current through 'L' at time $t=t_1$ and $t=t_0$.

6+10=16

Q.5. (A) Write down the conversion formulae of Delta-Wye and Wye-Delta network with suitable diagram.
(B) Show that required kVAR for improvement of power factor angle from Φ_i to Φ_f –

$$kW[\tan \Phi_i - \tan \Phi_f]$$

8+8=16