BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FIRST YEAR FIRST SEMESTER EXAMINATION, 2023

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)	Derive expression for capacitance of a cylindrical capacitor both for single dielectric and multi dielectric configurations.	6
1.b)	Derive an expression for potential energy in an electric field.	5
1.c)	Two capacitors of a capacitance 4 μF and 2 μF are joined in series with a battery of emf 100 V. The connections are then broken and like terminals of the capacitors are then joined. Find the charge on each capacitor.	5
2.a)	State and prove Gauss's law.	5
2.b)	Show that in a single core cable the ratio between the maximum to minimum value of stresses is equal to the ratio between the maximum radius of the cable to the radius of the conductor.	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)	State and explain Ampere's circuital law. Derive an expression for magnetic field strength due to a finite length of wire carrying current.	5
4.a)	Compare magnetic circuit with electric circuit.	5
4.b)	Deduce an expression for the coefficient of coupling for two magnetically coupled coils.	5

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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 whiie 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.	5
5.b)	Deduce an expression for the lifting power of a magnet.	5
5.c)	A cast steel electromagnet has an air gap length 2 mm and an iron path of length 30 cm. Find the total ampere turns necessary to produce a flux density of 0.8 tesla in the gap. The relative permeability of cast steel is 835.	6

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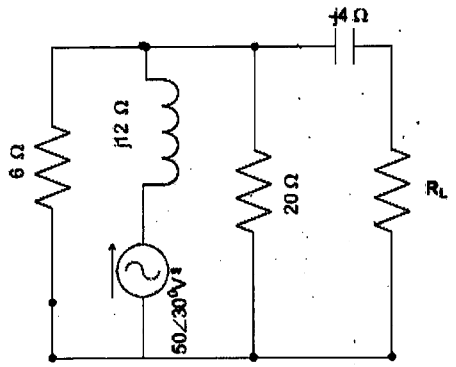
Part-II (50 Marks)
ANSWER ANY THREE QUESTIONS
QUESTION NO.1 CARRIES 18 MARKS

Q.1. (A) State the Maximum power transfer theorem applicable for an AC circuit.
(B) Apply the above theorem to determine the value of 'R_L' for which maximum power is transferred to load-



4+14=18

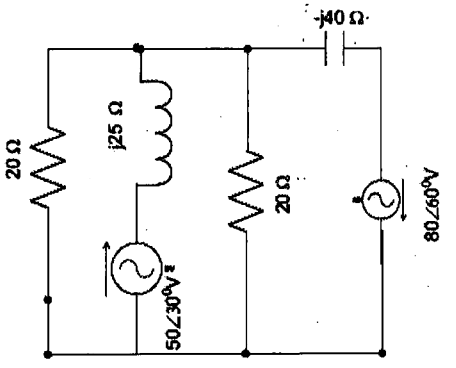
Q.2. (A) A coil of resistance 25Ω and inductance 0.159H is in parallel with a circuit having 60Ω resistor and 125 μF capacitor. The parallel circuit is connected to a 230V, 50Hz supply. Calculate (i) the supply current; (ii) the equivalent circuit impedance, resistance and reactance.
(B) A voltage, given by

$$v(t) = 150 \sin \omega t + 25 \sin(3\omega t + \pi/3)$$

is applied to a circuit containing a resistance of 12Ω in series with an inductor of 0.02H 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 the Superposition theorem applicable for an electrical circuit.
(B) Apply the above theorem to determine the current through the 20Ω resistor-



4+12=16

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Q.4. (A) A 2μF capacitor, initially charged to 200V, is discharged through a 250kΩ resistor. What is the capacitor voltage at 0.30s after the capacitor starts to discharge?
(B) How long a 20μF capacitor, charged to 300V, will take to discharge through a 170 kΩ resistor and what is the total energy dissipated in the resistor?
(C) 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 $t=t_0$.

5+5+6=16

Q.5. (A) Two loads, Load1 and Load2, are connected in parallel and connected to an ac voltage source(V). Load1 absorbs 5kW and 10kVAR and Load2 absorbs 3kW and generates 3kVAR. Determine the total power components, source voltage(V), the impedances of the Load1 and Load2.
(B) A parallel resonant circuit is known as tuned tank circuit – Explain.

10+6=16