

**BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FIRST YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION 2023**

**PRINCIPLES OF ELECTRICAL ENGINEERING - I**

**Full Marks 100**

**Time: Three hours**

**(50 marks for each part)**

**Use separate Answer script for each Part**

**Part I**

**Answer any three questions. Two marks are reserved for well-organized answers.**

- 1.a) Derive expression for capacitance of a parallel plate capacitor having three different dielectrics in between the two plates. Relative permittivities of the dielectrics are  $\epsilon_{r1}$ ,  $\epsilon_{r2}$  and  $\epsilon_{r3}$  respectively. 6
- b) Derive an expression for force of attraction between two oppositely charged plates. 5
- c) Three identical point charges each of Q coulomb are placed at the vertices of an equilateral triangle, the sides of which are 10 cm each. Find the force on each charge. 5
- 2.a) Deduce the expression for the energy stored in a capacitor. Also deduce the expression for the insulation resistance of a cable capacitor. 4+4
- b) A plate capacitor A is charged to 40  $\mu\text{C}$  at 100 V. It is then connected in parallel to a similar type capacitor B of 4 times the plate area of A. Find the charge on each capacitor and loss in energy. 8
- 3.a) Deduce an expression for magnetic field strength at a point due to a finite length of wire carrying current. 8
- b) Deduce the expression inductance when two coils are connected in (a) series and (b) parallel respectively. 4+4
- 4.a) Compare between magnetic and electric circuit. 6

[ Turn over

- b) A cast steel electromagnet has an air gap of 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
- c) Deduce an expression for the lifting power of a magnet. 4
- 5.a) Derive the expression for energy stored in magnetic field. 8
- b) Show that hysteresis loss in a magnetic material is proportional to the area of the hysteresis loop of that material. 4
- c) An air – cored solenoid 1 m in length and 10 cm in diameter has 5000 turns. Calculate (a) the self - inductance and (b) the energy stored in the magnetic field when a current of 2 A flows in the solenoid. 4

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**1<sup>ST</sup> YEAR 1<sup>ST</sup> SEMESTER SUPPLEMENTARY EXAMINATION 2023**  
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Time: 3 hours

Use Separate Answer script for each part

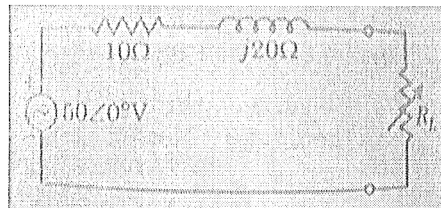
Full Marks:100

**Part-II (50 Marks)**

**ANSWER ANY THREE QUESTIONS**

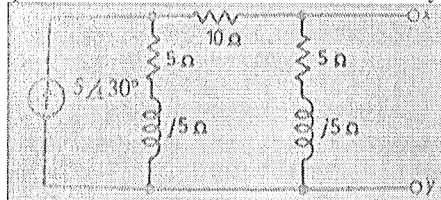
**QUESTION NO.1 CARRIES 18 MARKS AND REST CARRY 16 MARKS EACH**

Q.1. State the Maximum power transfer theorem for an AC circuit and apply the theorem to determine  $R_L$  for maximum power transferred for the following circuit and determine the power.



Q.2. Explain the Thevenin's theorem and Norton's theorem with suitable example for each.

Q.3. (A) Obtain the Norton equivalent circuits at the terminal 'x-y' of the following network.



(B) State and explain the Superposition theorem applicable for an electrical circuit.

Q.4. (A) A coil of resistance  $50\Omega$  and inductance  $0.169\text{H}$  is in parallel with a circuit having  $65\Omega$  resistor and  $120\mu\text{F}$  capacitor. The parallel circuit is connected to a  $230\text{V}$ ,  $50\text{Hz}$  supply. Calculate (i) the supply current; (ii) the equivalent circuit impedance, resistance and reactance.

(B) A voltage, given by  $e = 100 \sin \omega t + 50 \sin(5\omega t + \pi/6)$  is applied to a circuit containing a resistance of  $20\Omega$  in series with an inductor of  $0.05\text{H}$  and negligible resistance.

If the fundamental frequency is  $50\text{ Hz}$ , calculate (i) the power dissipated (ii) the power factor for the circuit.

Q.5. (A) A  $20\mu\text{F}$  capacitor, initially charged to  $200\text{V}$ , is discharged through a  $200\text{k}\Omega$  resistor. What is the capacitor voltage at  $0.25\text{s}$  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  $t=t_0$ .