Ref. No. Ex/ES/EE/T101B/2024

B.E. Electrical Engineering First Year Second Semester Examination, 2024

Basic Electrical Engineering

Time: Three Hours **Full Marks: 100**

(50 Marks for each part)

Use a separate Answer Script for each Part

PART-I

Answer one question from each Group (3X16). 2 marks reserved for neatness and well organized answers. Assume reasonable values for missing data, if any.

Group A (Answer any one question-16 marks)

1. a) What do you understand by Q-factor in a parallel ac circuit? A resistor is connected in series with a capacitor of 35 microfarad and the combination is connected across 50Hz supply. Determine the value of the resistor if the voltage across the capacitor is half of the supply voltage. Draw the phasor diagram of the circuit showing all relevant voltages and current.

[2+4+2]

b) Prove that the locus of the current in a series R-C circuit with variable C is a semicircle. Draw and explain the locus diagram of the total current when a real inductive coil with constant parameters is connected in parallel with the above circuit. All notations/symbols carry their usual meaning. Assume notations/symbols for other parameters for drawing the locus, if necessary.

[4+4]

2. a) What do you understand by the "admittance" of an electric circuit? A 15ohm resistor in parallel with a pure inductor is connected across a 240V variable frequency source. The total current is 22.1A when frequency is 50Hz. Determine the frequency when the total current is 34A. [2+6]

b) What do you understand by "**dynamic impedance**" of a parallel resonant ac circuit? A capacitor with 2 ohm reactance is connected in series with a variable resistor. A coil of (10+j10) ohm is connected in parallel with the above combination. Determine the value of the resistance of the variable resistor which will lead to resonance, showing necessary steps of calculation.

[3+5]

Group B (Answer any one question- 16 marks)

3.a) If the half power frequencies of a series R-L-C circuit are 90kHz and 10 kHz, what is the resonant frequency?

A series R-L-C circuit is supplied with an ac source of variable frequency, ω. At which value of the frequency (ω) the voltage across the inductor will be the maximum? Express this value of ω in terms of resistance (R), inductance (L), capacitance (C) and resonating frequency of the series circuit (ω_0).

[2+6]

[Turn over

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b) State Thevenin's theorem. Determine the current through the 10 ohm resistor in **Fig. 1** using Thevenin's theorem. [2+6]

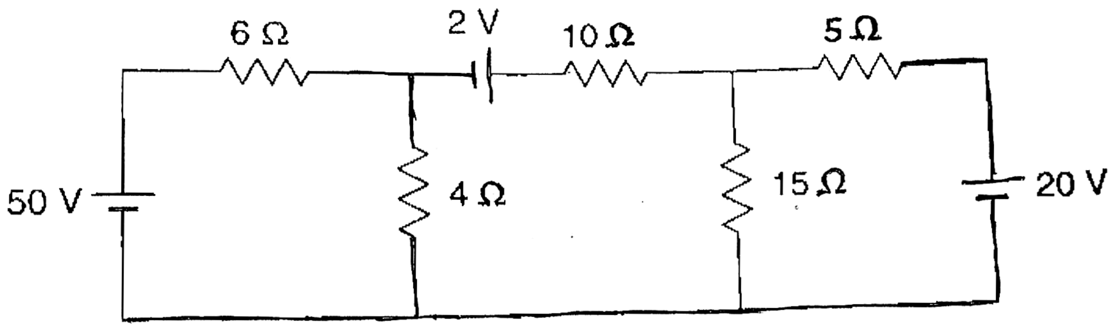

Fig. 1

4. a) State Superposition Theorem for ac network. Mention the limitations of Superposition theorem. Determine the value of the load impedance Z_L to be connected across terminals A and B in **Fig. 2** for maximum power transfer if i) Z_L consists of a variable resistance only ii) Z_L consists of a variable resistance and a variable reactance iii) Z_L consists of a variable resistance and a fixed reactance of 7.1 ohms. [1+1+6]

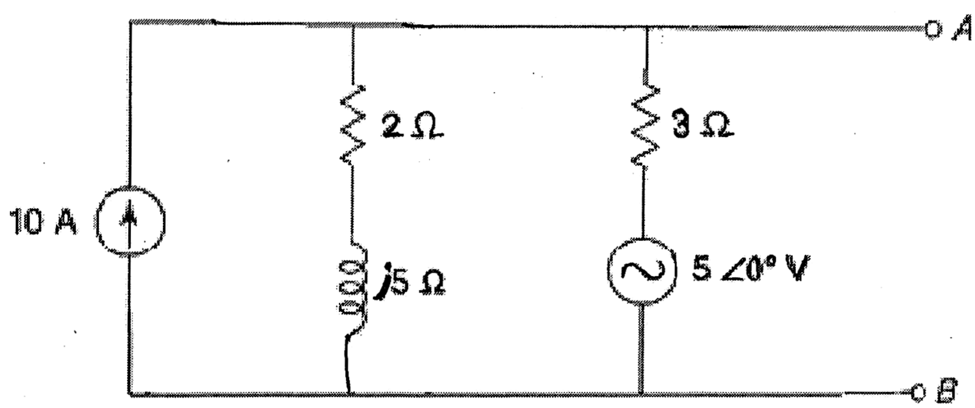

Fig. 2

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b) Determine the current in the 20-ohm resistor in **Fig. 3** using Norton's theorem. Assume that the voltage source has an internal resistance of 1 ohm. [8]

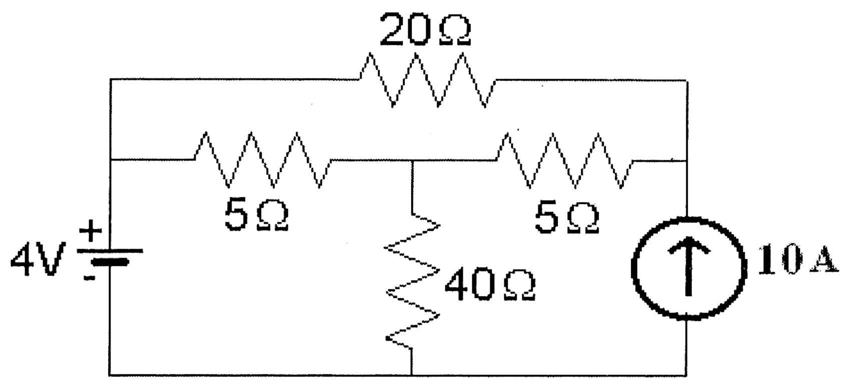

Fig. 3

Group C (Answer any one question- 16 marks)

5. a) State the expression for the energy density in a magnetic field in terms of flux density and permeability.

The length and cross sectional area of a horse-shoe electromagnet are 50cm and 10 sq. cm respectively. Determine the exciting current necessary to lift a load of 80 kg which is making close contact with the magnet. Consider that the exciting coil has 1000 turns and the relative permeability of the magnetic material to be 700. Derive the necessary formula used. [1+3+4]

b) Determine the exciting current required to set up flux of 1 mWb in the central limb of the magnetic circuit shown in **Fig. 4.** The coil is wound with 500 turns and cross section of the central and two identical side limbs are shown in the figure. Air gap of 1mm is provided on both sides of the central limb as shown in the figure. The magnetic field intensities are 600AT/m and 2100AT/m for flux densities of 1.25Wb/m^2 and 1.67Wb/m^2, respectively. [8]

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Time: Three Hours **Full Marks: 100**

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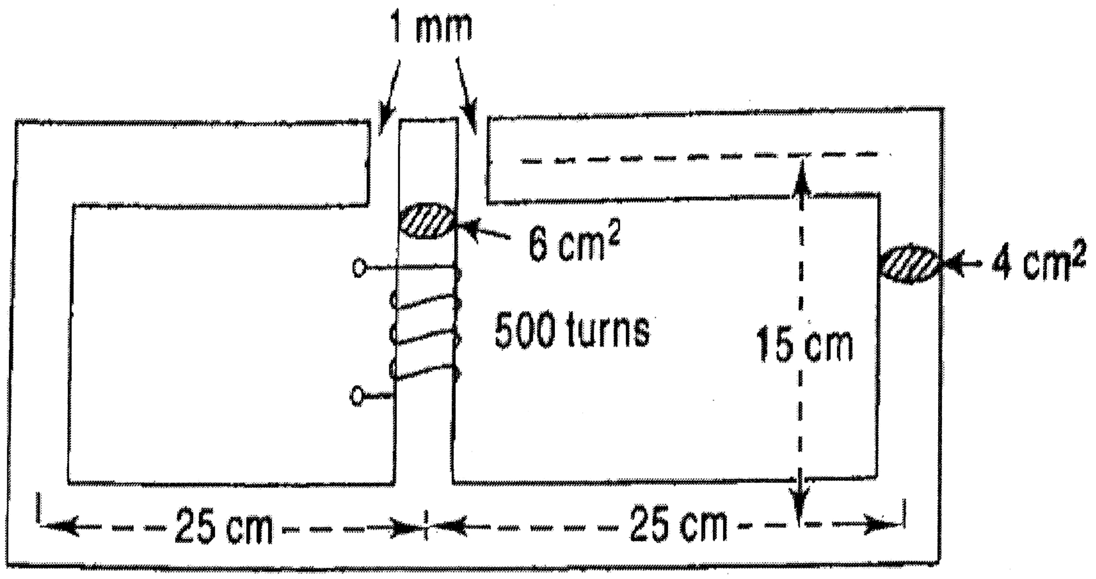

Fig. 4

6. a) Explain what you understand by an ***Ideal Transformer.*** Draw and explain the equivalent circuit of an ideal transformer referred to primary with a load impedance $\mathbf{Z_L}$ connected to secondary. [4+4]

b) Find the current through the load Z_L of the network shown in Fig. 5. Assume Z_L= (6-j8) Ω. [8]

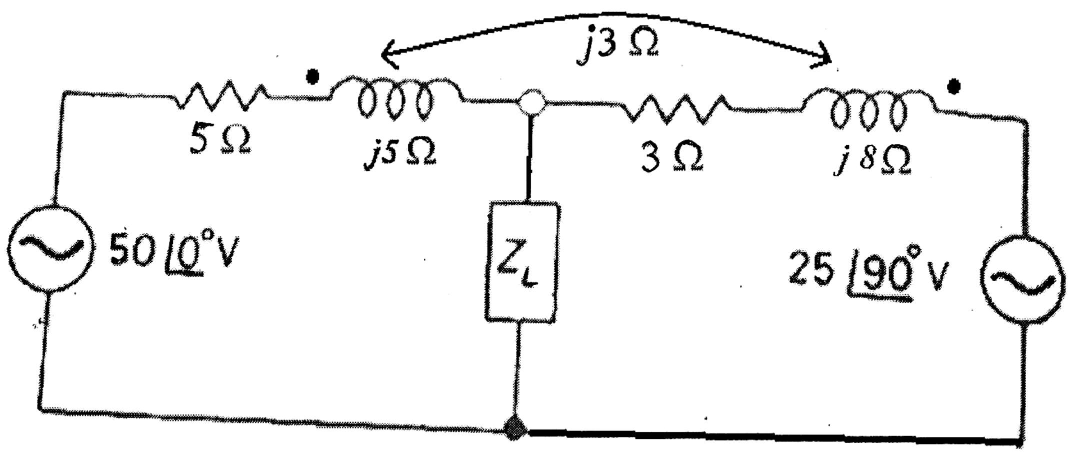

Fig. 5

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BASIC ELECTRICAL ENGINEERING

Full Marks 100

Time: Three hours

(50 marks for each part)

Use a separate Answer-Script for each part.

PART II

Answer any three questions.
Two marks are reserved for neat and well organized answers.

1.a) Deduce an expression for capacitance of a cylindrical capacitor. 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. 4+4

or

With the help of a diagram explain the major parts of a dc machine. 8

1.b) With the help of necessary circuit diagram and phasor diagrams establish the relationship between the phase and line quantities in the cases of three phase star and delta connections respectively. Also derive the expression for power in the above two cases. 4+4

2.a) A balanced three-phase star connected load is drawing total active power of 8kW from 440V, 50Hz supply at a power of 0.75 (lag). The load per phase consists of an inductive coil having a resistance of 5Ω and an inductance of L Henry in series with a capacitance of 100μF. Calculate the inductance L of the coil. 8

2.b) 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. 4

2.c) Comment on the behaviour of zero sequence components of voltage and current in the following cases: 4
(1) Four wire connection, and (2) Three wire delta connection.

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3.a) Deduce an expression for the current flowing through neutral wire in the case of a three phase four wire unbalanced system with line impedances. 6

3.b) Determine the voltage across the loads, line currents and neutral shift in an unbalanced, three-phase, three wire, star-connected load supplied from a symmetrical 3- phase, 50Hz, 440-V system. The branch impedances of the load are Z_R = (4.33+j2.5) Ω, Z_Y = (7.07+j7.07) Ω, and Z_B = (5+j8.66) Ω respectively. The phase sequence is RYB. Draw the phasor diagram. 10

4.a) "Two wattmeter method of power measurement is independent of the physical position of star point" – justify the statement. 6

4.b) A delta-connected load has impedances Z_{RY} = (10 + j 5) Ω, Z_{YB} = (15 + j 15) Ω, and Z_{BR} = (5 + j 8) Ω and is connected to a 400 V supply of phase sequence RYB. Calculate the readings of two wattmeters with current coils in lines R and B respectively and voltage coils connected to line y. Also calculate average power factor and vector power factor of the load. 10

5.a) Are the following waves of similar wave shape? Give reason. 5

$e = 100\sin(\omega t + 30^0) - 50\cos 2\omega t + 25\sin(5\omega t + 150^0)$ volts

$i = 20\sin(\omega t + 40^0) + 10\sin(2\omega t + 30^0) - 5\sin(5\omega t - 50^0)$ amperes

5.b) Write the general expression for the following non-sinusoidal wave. 4

$V = 8\sin\omega t - 6\cos\omega t - 7.66\sin 2\omega t + 6.43\cos 2\omega t - 4\sin 3\omega t - 3\cos 3\omega t$

5.c) The emf of one phase of a 50-Hz, 3-phase, delta-connected alternator is $565\sin\theta + 50\sin 3\theta - 30\sin 5\theta\ V$. If the resistance and inductance per phase are 0.25Ω and 5 mH, find the r.m.s. value of (a) the current circulating in the windings, and (b) the current in a 50-μF capacitor connected across a pair of lines. 7