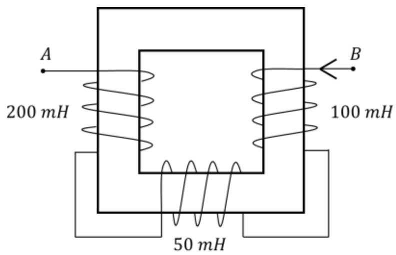
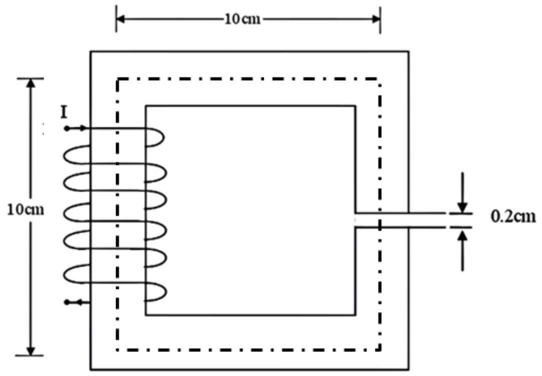
Manipal Institute of Technology			
Course	**Basic Electrical Technology**	**Exam**	**In-Semester 2, Marks: 15, Duration: 60 Min**
Course Code	**ELE 1071**	**Date & Time**	**05 Dec 2022, 11:00 AM – 12:00 Noon**
Semester	**First, First Year B.Tech.**	**Branch**	**Chemistry Cycle**

Part A – Objective Questions

<table>
<tr><th>Q. No.</th><th>Question</th><th>Marks</th><th>BTL</th><th>CO</th><th>PO</th><th>LO</th></tr>
<tr><td>1</td><td>A circular magnetic core of mean length 35 cm with cross-sectional area 15 cm² has a coil of 1000 turns. The coil produces a flux of 1.275 mWb. The current in the coil for the following magnetic characteristic of the core is:
<table>
<tr><td>H (A/m)</td><td>400</td><td>560</td><td>800</td></tr>
<tr><td>B (T)</td><td>0.7</td><td>0.85</td><td>1</td></tr>
</table>
a) 29.75 mA   b) 84 mA   c) 19.6 A   d) 196 mA</td><td>1</td><td>3</td><td>2</td><td>1, 2</td><td>1, 2, 4</td></tr>
<tr><td>2</td><td>If the three coupled coils shown have coupling coefficients of 0.7, the equivalent inductance between the terminals A & B is:


a) 193 mH
b) 391 mH
c) 589 mH
d) 309 mH</td><td>1</td><td>3</td><td>2</td><td>1, 2</td><td>1, 2, 4</td></tr>
<tr><td>3</td><td>The three parallel branches of an AC circuit carry the following currents:
$i_1 = 20 \sin(314t)$
$i_2 = 30 \sin(314t - \pi/4)$
$i_3 = 40 \cos(314t + \pi/6)$
Then, the resultant current _____ the current i_1 and its RMS value is _____ A.
a) is in phase with, 17.75   b) Leads, 25.1   c) Lags, 25.1   d) Leads, 17.75</td><td>1</td><td>3</td><td>3</td><td>1, 2</td><td>1, 2, 4</td></tr>
<tr><td>4</td><td>The value of conductance and susceptance respectively for the complex impedance (50 – j 150) Ω are:
a) 0.02 and 0.0067 Siemens
b) 0.1 and 0.9 Siemens
c) 0.002 and 0.006 Siemens
d) 0.002 and – 0.006 Siemens</td><td>1</td><td>3</td><td>3</td><td>1, 2</td><td>1, 2, 4</td></tr>
<tr><td>5</td><td>A 230 V, 50 Hz single-phase AC circuit consists of a resistor, a variable inductor, and a capacitor in series. The maximum current obtainable on varying the inductor is 2.74 A when the voltage across the capacitor is 344 V. The resistance and inductance of the circuit are respectively:
a) 84 Ω and 267 mH
b) 84 Ω and 400 mH
c) 125.5 Ω and 400 mH
d) 125.5 Ω and 267 mH</td><td>1</td><td>3</td><td>3</td><td>1, 2</td><td>1, 2, 4</td></tr>
</table>

Part B – Descriptive Questions

<table>
<tr><th>Q. No.</th><th>Question</th><th>Marks</th><th>BTL</th><th>CO</th><th>PO</th><th>LO</th></tr>
<tr><td>6</td><td>The magnetic circuit shown has uniform cross-sectional area 10 cm² and an air gap of 0.2 cm. When the core relative permeability is assumed to be infinite, the magnetic flux density computed in the air gap is 1 T. With same Ampere-turns, if the core relative permeability is assumed to be 1000 (linear), determine
a) The flux density calculated in the air gap
b) Reluctance of the core and the air gap
c) The circuit inductance with 500 turns
Assume no magnetic leakage & fringing.

</td><td>3</td><td>4</td><td>2</td><td>1, 2</td><td>1, 2, 4</td></tr>
<tr><td colspan="7">

(a) **Case 1**: $\mathbf{S_c = 0}$ $\quad \because \ \boldsymbol{\mu_r = \infty}$

$NI = \emptyset\,(S_g + S_c) = B_1 \times A\left(\frac{L_g}{\mu_0 \times A}\right) = B_1 \times \frac{0.2}{\mu o}$ -------- 0.5 M

Case 2: $\mathbf{S_c \neq 0}$ $\quad \because \ \boldsymbol{\mu_r = 1000}$

$NI = \emptyset\,(S_g + S_c) = B_2 \times A\left(\frac{L_g}{\mu_0 \times A} + \frac{L_c}{\mu_0 \times \mu_r \times A}\right) = B_2 \times \frac{0.2398}{\mu_0}$ --------- 1 M

$B_1 \times \frac{0.2}{\mu o} = B_2 \times \frac{0.2398}{\mu_0}$ $\quad$ *Or* $\quad \mathbf{B_2 = 0.834\ T}$ --------- 0.5 M

(b) $\mathbf{S_g} = \frac{L_g}{\mu_0 \times A} = \mathbf{1591549.431\ AT/Wb}$ $\quad$ & $\quad \mathbf{S_c} = \frac{L_c\ (= 39.8\ cm)}{\mu_0 \times \mu_r \times A} = \mathbf{316718.337\ \ AT/Wb}$ --------- 0.5 M

(c) $\mathbf{L} = \frac{N^2}{S_T} = \frac{500^2}{1591549.431 + 316718.337} = \mathbf{0.131\ H}$ **Or 131 mH** --------- 0.5 M

</td></tr>
<tr><td>7</td><td>A single-phase motor takes 15 A at a power factor of 0.6 lagging from a 230 V, 50 Hz supply. Determine (i) the capacitance of the capacitor, and the current taken by it, connected in parallel with the motor to correct the power factor to 0.9 lagging, and (ii) the value of the supply current after power factor correction.</td><td>3</td><td>3</td><td>3</td><td>1, 2</td><td>1, 2, 4</td></tr>
<tr><td colspan="7">

$\text{Cos}\,\emptyset = 0.6$ Lagging $\quad$ Or $\quad \emptyset = 53.13°$ $\quad$ and $\quad \overline{V} = 230\angle 0°\ V$

$\mathbf{P} = V\,I\,\text{Cos}\,\emptyset = 230 \times 15 \times 0.6 = \mathbf{2070\ W}$

$\mathbf{Q_M} = V\,I\,\text{Sin}\,\emptyset = 230 \times 15 \times \text{Sin}\,53.13° = \mathbf{2760\ VAr\ (Lagging)}$ --------- 0.5 M

$\text{Cos}\,\emptyset_{New} = 0.9$ Lagging $\quad$ Or $\quad \emptyset_{New} = 25.842°$

$\mathbf{Q_{New}} = 2070 \times \text{Tan}\,25.842° = \mathbf{1002.549\ VAr\ \ (Lagging)}$ --------- 0.5 M

$\mathbf{Q_C} = Q_M - Q_{New} = \mathbf{1757.451\ \ (Leading)}$ --------- 0.5 M

$Q_C = \frac{V^2}{X_C}$ $\quad$ Or $\quad \mathbf{X_C = 30.1\ \Omega}$ $\quad$ Or $\quad \mathbf{C} = \frac{1}{2\pi\,f\,X_C} = \mathbf{105.751\ \mu F}$ --------- 0.5 M

$\mathbf{I_C} = \frac{V}{X_C} = \mathbf{7.641\angle 90°\ A}$ --------- 0.5 M $\quad$ **and** $\quad \mathbf{I_{New}} = \frac{P}{V\,\text{Cos}\,\emptyset_{New}} = \mathbf{10\ A}$ --------- 0.5 M

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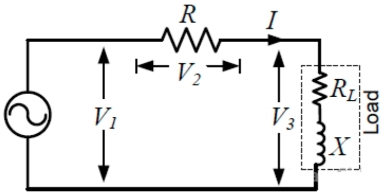
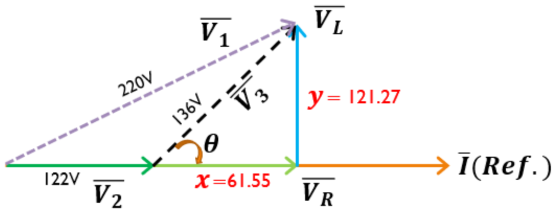
8	In the circuit below, the RMS values of the voltages are given as **V_1 = 220 V, V_2 = 122 V,** and **V_3 = 136 V.** The supply frequency is **50 Hz.** If **R_L = 5 Ω,** determine (a) power consumption of the load, (b) power factor of the load & that of the circuit, (c) inductance of the load & remaining resistance, and (d) draw the phasor diagram for the circuit. 	4	3	3	1, 2	1, 2, 4



-------- 1 M

$(122 + x)^2 + y^2 = 220^2$ and $x^2 + y^2 = 136^2$

Or $122^2 + 136^2 + (2 \times 122 \times 136 \times \text{Cos}\,\theta) = 220^2$ Or $\mathbf{Cos\,\theta = 0.4526}$ Or $\mathbf{\theta = 63.09°}$

$\text{Cos}\,\theta = \frac{V_{R_L}}{136}$ or $\mathbf{V_{R_L} = 61.554\ V}$ ∴ **Circuit Current,** $\mathbf{I} = \frac{V_{R_L}}{5} = \mathbf{12.311\ A}$ – – – – – – – 1 M

$\mathbf{P_{Load}} = 12.311^2 \times 5 = \mathbf{757.804\ W}$ **Resistance,** $\mathbf{R} = \frac{122}{12.311} = \mathbf{9.91\ \Omega}$ – – – – – – – 0.5 M

$\mathbf{PF_{Load}} = \text{Cos}\,\theta = \mathbf{0.4526\ Lagging}$ – – – – 0.5 M **and** $\mathbf{PF_{Circuit}} = \frac{122 + 61.554}{220} = \mathbf{0.834\ Lagging}$ – – – 0.5 M

$\mathbf{X_L} = \frac{V_L}{I} = \frac{136\ \times \text{Sin}\ 63.09°}{12.311} = \mathbf{9.8508\ \Omega}$ Or $\mathbf{L} = \frac{9.8508}{2\pi \times 50} = \mathbf{31.356\ mH}$ – – – – – – – 0.5 M