AMITY UNIVERSITY
UTTAR PRADESH

MODEL ANSWER

(End Semester Examination: April 2024)

Institution: Amity School of Engineering and Technology, Noida

Domain Name: Engineering & Technology

Stream Name: Electrical Engineering / Instrumentation Engineering

Course Code: ES103

Course Title: Basic Electrical Engineering

Model Answer Prepared By :

S. No.	Name of Faculty	Emp. Code	Signature of faculty
1	Mehtab fatima	0788	
2			

I confirm that the meeting of the above faculties has been convened.

19/4/24

Signature of HoI/HOD with Seal

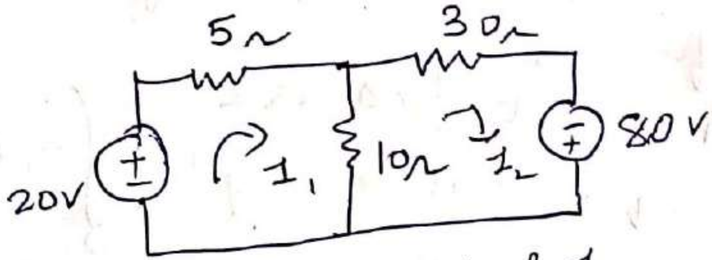
Model Answer

Basic Electrical Engineering
ES103
End Term Examination
April-May, 2024

—— × —— × —— × —— ×

Section A

Soln 1:



Assuming mesh currents I_1 & I_2

KVL in mesh 1 is

$$20 - 5I_1 - 10(I_1 - I_2) = 0$$

$$20 - 15I_1 + 10I_2 = 0$$

$$15I_1 - 10I_2 = 20 \quad \text{—(1)}$$

(2 marks)

KVL in mesh 2 is

$$-30I_2 + 80 - 10(I_2 - I_1) = 0$$

$$10I_1 - 40I_2 + 80 = 0$$

$$10I_1 - 40I_2 = -80 \quad \text{—(2)}$$

(2 marks)

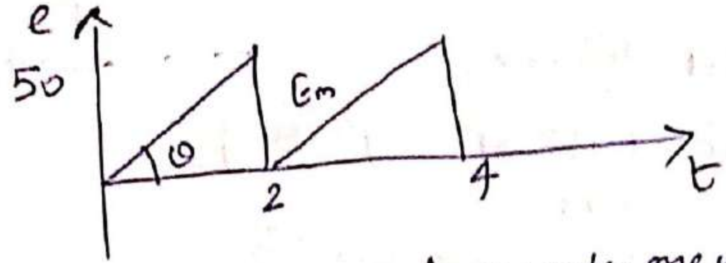
Solving (1) & (2) $I_1 = 3.2$ $I_2 = 2.8$

Thus current through $10\Omega = I_1 - I_2 = 3.2 - 2.8$
$= 0.4A$ (downward direction)

(2 marks)

Soln 2: Form factor: It is defined as ratio of RMS value to average value.

(1 marks)



Average value = $\dfrac{\text{Area under one cycle}}{\text{one cycle length}}$

$= \dfrac{\frac{1}{2} \times 2 \times 50}{2} = \underline{25 \text{ volts}}$. (2 marks)

RMS value = $\sqrt{\dfrac{\text{Area of Sq. wave under one cycle}}{\text{one cycle length}}}$ —(1 mark)

Wave is defined as

$e_1 = 25t$ for $0 < t < 2$

$\therefore$ Area of Sq. wave under one cycle $= \displaystyle\int_0^2 e_1^2(t)\,dt$;

$= \displaystyle\int_0^2 25^2 t^2\,dt = 625\left[\frac{t^3}{3}\right]_0^2$

$= 625 \times \dfrac{8}{3} = 1666.67$ (1 mark)

$\therefore$ RMS Value $= \sqrt{\dfrac{1666.67}{2}} = \underline{28.87 \text{ volts}}$.

$\therefore$ Form factor $= \dfrac{\text{RMS value}}{\text{Avg value}} = \dfrac{28.87}{25} = \underline{1.155}$ (1 mark)

Soln 3: Shunts — low resistance in parallel with PMMC coil to increase the range of PMMC Ammeter (2 marks)

Multiplier — high resistance in series with PMMC coil to increase the range of PMMC voltmeter. (2 marks)

As given $R_m = 5\,\Omega$

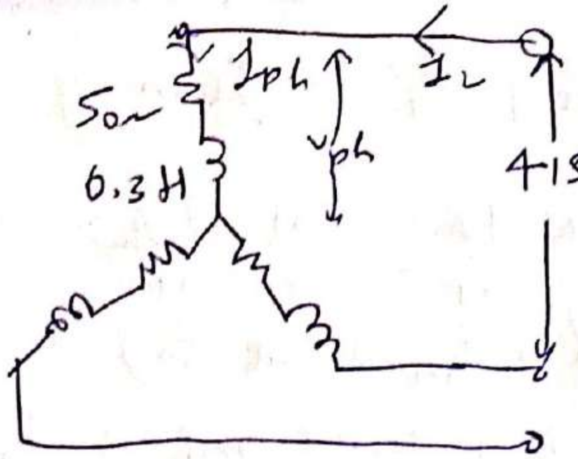
$I_m = 15\,mA$

$I = 1\,A$

$S = ?$ (2 marks)

$S = \dfrac{I_m R_m}{I - I_m} = \dfrac{0.015 \times 5}{1 - 0.015} = \underline{0.0761\,\Omega}$

Soln 4:



$V_L = 415V \quad R_{ph} = 50\Omega \quad L_{ph} = 0.3H$

$\therefore X_{ph} = \omega L_{ph} = 2\pi f \times L_{ph} = 2 \times 3.14 \times 50 \times 0.3$
$= 94.2\,\Omega$

$\therefore Z_{ph} = \sqrt{R_{ph}^2 + X_{ph}^2} = \sqrt{50^2 + 94.2^2} = \underline{106.65\,\Omega}$

$\Rightarrow I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{V_L/\sqrt{3}}{106.65} = \frac{415/\sqrt{3}}{106.65} = \underline{2.25A}$

$\therefore I_L = I_{ph} = \underline{2.25A}$ —— (2 marks)

Power Consumed = $\sqrt{3} V_L I_L \cos\phi$

where ⇒ $\cos\phi = \frac{R_{ph}}{Z_{ph}} = \frac{50}{106.65} = \underline{0.468}$ (2 marks)

$\therefore P = \sqrt{3} V_L I_L \cos\phi = \underline{756.89 \text{ Watts}}$ (2 marks)

Soln 5:

EMF Eqn of transformer is given by

$E_1 = 4.44 f \phi_m N_1$

& $E_2 = 4.44 f \phi_m N_2$

Derivation: Consider an AC supply of V_1 & freq f is applied to primary side of transformer. The flux produced in primary is $\phi_1 = \phi_m \sin\omega t$

The induced emf e_1 as primary as per Faraday law is

$$e_1 = -N_1 \frac{d\phi}{dt} = -\frac{N_1 \, d(\phi_m \sin\omega t)}{dt}$$

$$e_1 = 2\pi f N_1 \phi_m \sin(\omega t - 90^\circ) \quad \text{——} (1)$$

The max value of induced emf is $E_{m_1} = 2\pi f N_1 \phi_m$

RMS value is thus

$$E_1 = \frac{E_{m_1}}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}} = 4.44 f \phi_m N_1$$

Similarly $E_2 = 4.44 f \phi_m N_2$ (4 marks)

Turns ratio is ratio of no of turns of secondary winding to no of turns of primary winding. (2 marks)

$$K = \frac{N_2}{N_1} = \frac{E_1}{E_2} = \text{turns ratio}$$

Section B

Soln 6 (a) $Z = 208\Omega$ $V = 130$ volts

$f = 60$ Hz

$R = 145\Omega$

$$Z = \sqrt{R^2 + X_c^2}$$

$$X_c = \sqrt{Z^2 - R^2}$$

$$= \sqrt{208^2 - 145^2} = 149.13\Omega \quad \text{as } X_c = \frac{1}{2\pi f C}$$

(i) $\therefore C = \frac{1}{X_c \times 2 \times 3.14 \times 60} = 17.79\ \mu F$ (2 marks)

(ii) $P = VI\cos\phi \Rightarrow$ where $\cos\phi = \frac{R}{Z} = 0.697$ (4 marks)

$\therefore$ & $I = \frac{V}{Z} = \frac{130}{208} = 0.625A$

(ii) $\therefore P = 130 \times 0.625 \times 0.697$

$= \underline{56.63\,W}$ (2 marks)

6(b) Resonance is a condition in RLC series circuit when its power factor becomes unity i.e voltage & current in the circuit are in phase. (2 marks)

Resonant freq derivation $f_r = \frac{1}{2\pi\sqrt{LC}}$ (3 marks)

At resonance $X_L = X_C$

$$\omega_r L = \frac{1}{\omega_r C}$$

$$2\pi f_r L = \frac{1}{2\pi f_r C}$$

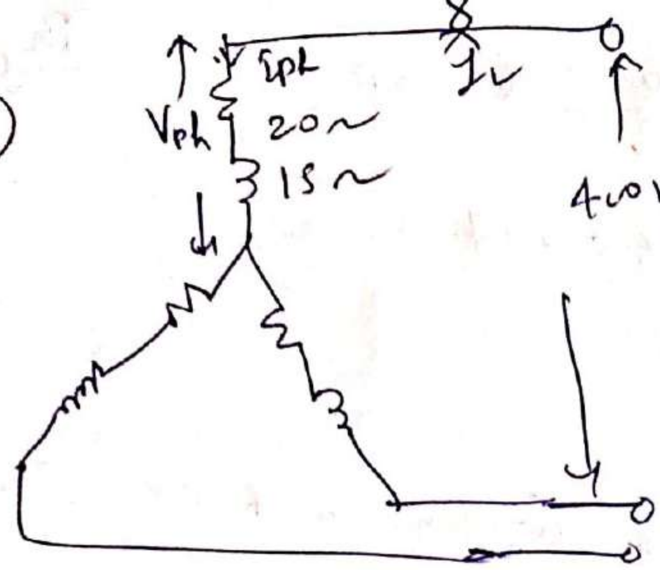
$$\Rightarrow \boxed{f_r = \frac{1}{2\pi\sqrt{LC}}}$$

Soln 7(a) Power Measurement methods – three wattmeter method & its connection diagram (2 marks)

Two wattmeter method & its connection diagram (2 marks)

Two wattmeter method is preferred as method is independent of source unbalance, load unbalance, type of supply etc. (1 mark)

7(b)



$X_L = \omega L \Rightarrow L = \dfrac{X_L}{2\pi f} = \dfrac{15}{2 \times 3.14 \times 50} = \underline{0.047\,H}$ (1 mark)

$Z = \sqrt{R^2 + X_L^2} = \sqrt{20^2 + 15^2} = \underline{25\Omega}$ (1 mark)

$I_L = I_{ph} = \dfrac{V_{ph}}{Z} = \dfrac{V_L/\sqrt{3}}{Z} = \dfrac{400/\sqrt{3}}{25} = \underline{9.23\ A}$ (1 mark)

(1 mark)

$\cos\phi = \dfrac{R}{Z} = \dfrac{20}{25} = \underline{0.8}$ (1 mark)

$P = \sqrt{3}\, V_L I_L \cos\phi = \underline{5115.78\ \text{Watts}}$

Soln 8(a) DC Machines

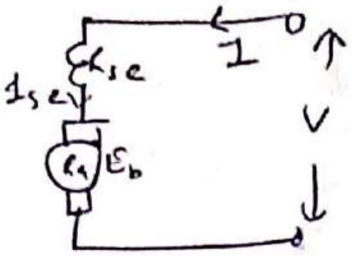
- Separately excited
- Self excited
  - Series wound
  - Shunt wound
  - Compound wound
    - Short shunt
    - Long shunt

Classification with diagrams of each (3 marks)

(3 marks)

Different types of DC Motors

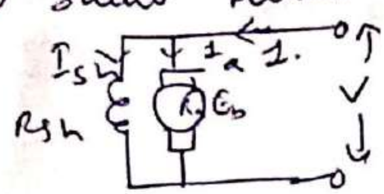
(1) series Motor



$I = I_{se} = I_a$

$E_b = V - IR_{se} - IR_a$

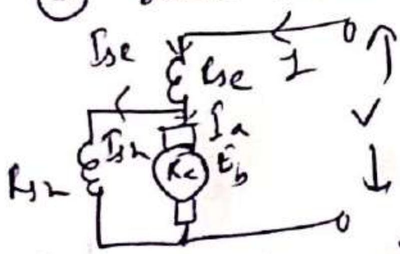
(2) Shunt Motor



$I = I_a + I_{sh} = I_a + \frac{V}{R_{sh}}$

$E_b = V - I_a R_a$

(3) Short shunt compound Motor



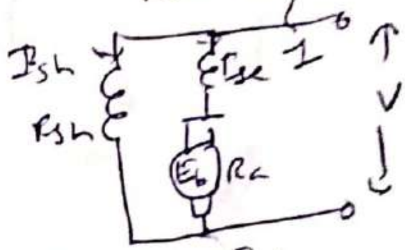
$I = I_{se}$

$I_a = I - I_{sh}$

$E_b = V - IR_{se} - I_a R_a$

$I_{sh} = \frac{V - IR_{se}}{R_{sh}}$

(4) Long shunt compound Motor



$I = I_{se} + I_{sh}$

$I_{se} = I_a$

$V = E_b + I_{se}R_{se} - I_a R_a$

$I_{sh} = \frac{V}{R_{sh}}$

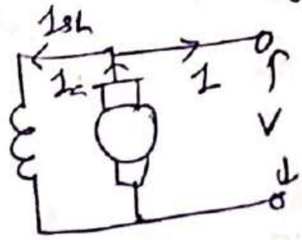
8(b)

$I_L = 450\ A$

$V = 230V$

$R_{sh} = 50\Omega$

$R_a = 0.03\Omega$



As $E_g = V + I_a R_a$

& $I_a = I + I_{sh} = 450 + \frac{V}{R_{sh}} = 450 + \frac{230}{50} = 454.6A$

$\therefore E_g = V + I_a R_a$

$= 230 + 454.6 \times 0.03$

$\boxed{E_g = 243.64 \text{ volts}}$

(4 marks)

Section C

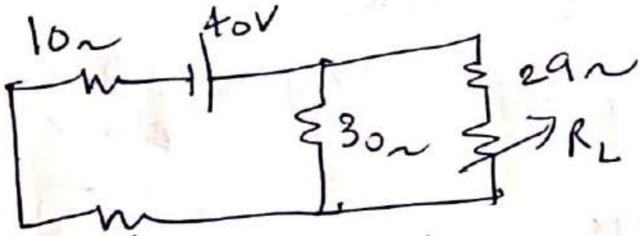
Soln 9(a) PMMC Instrument

Construction with diagram — (2 marks)

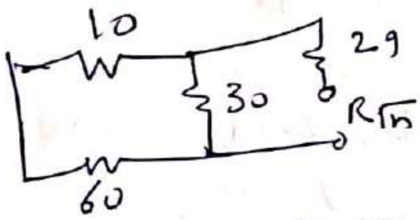
Working explanation — (2 marks)

Merits & demerits — (2 marks)

9(b) Maximum Power Transfer Theorem — Statement (2 marks)



$R_L = R_{Th}$

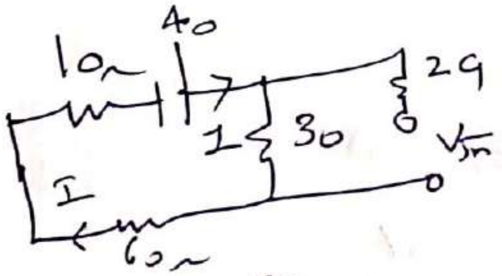


$R_L = (70 \parallel 30) + 29 = \underline{50\Omega}$ (1 marks)

(1 mark)

$P_{max} = \dfrac{V_{Th}^2}{4R_L}$

V_{Th} calculation:

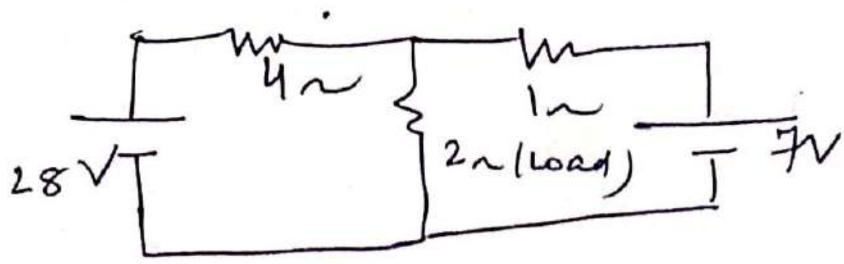


V_{Th} = voltage across 30Ω

$= I \times 30 = \dfrac{40}{10+30+60} \times 30 = 12$ volts

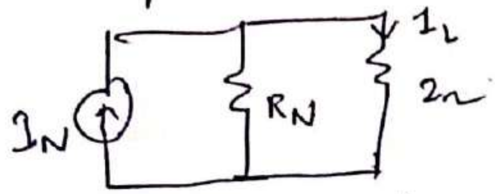
$\therefore P_{max} = \dfrac{V_{Th}^2}{4R_L} = \dfrac{12^2}{4 \times 50} = \underline{0.72 \text{ Watts}}$ (1 marks)

9(c)



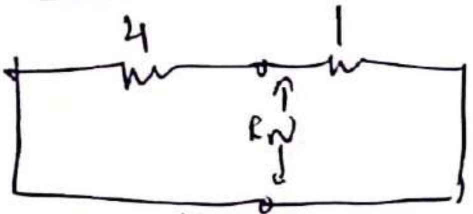
(1 mark)

Norton's equivalent circuit is



$$\Rightarrow I_L = \frac{R_N}{R_N + 2} \times I_N \quad \text{— Eqn (1)}$$

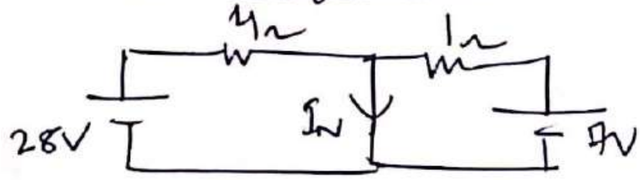
R_N is



$$\Rightarrow R_N = 4 \parallel 1 = \frac{4}{5}\,\Omega$$

(1 mark)

I_N is



$$\Rightarrow I_N = \frac{28}{4} + \frac{7}{1} = 14A$$

(1 mark)

Using Eqn (1)

$$I_L = \frac{4/5}{4/5 + 2} \times 14 = 4A$$

(2 marks)

—— × ———— × End ———— × ————

Ms. Mehtab Fatima
Employee code: 0788

19/4/24