Modified

CBCS SCHEME

USN | | | | | | | | | | |

18EC36

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Power Electronics and Instrumentation

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Discuss various power converter circuits with necessary sketches and applications of each. **(07 Marks)**

b. With necessary sketches, explain the static V-I characteristics of SCR and its operation. **(08 Marks)**

c. List different turn-on methods, explain all in brief. **(05 Marks)**

OR

2 a. Explain turn-ON/turn-OFF dynamic characteristics of SCR with neat diagram. **(07 Marks)**

b. With suitable diagram and waveform, explain the working of RC full wave firing circuit. **(08 Marks)**

c. Describe the operation of UJT with neat sketches. **(05 Marks)**

Module-2

3 a. Explain the working of 1ϕ full wave center tapped controlled rectifier for resistive load with necessary sketches and also develop mathematical model to evaluate performance parameter of same (V_{dc}, V_{rms}, Efficiency). **(10 Marks)**

b. Evaluate performance parameter of 1ϕ half controlled rectifier with resistive load, has a transformer secondary voltage of 230V, 50Hz with R = 10Ω and firing angle α = 60°. Determine:

i) Average voltage and current
ii) Rms value of voltage and current
iii) Efficiency
iv) Ripple factor
v) Form factor. **(10 Marks)**

OR

4 a. Input to the step-up chopper is 200V the output required is 600V, if the conduction time of thyristor is 200μsec. Compute:

i) Chopping frequency
ii) If the pulse width is halved for constant frequency operation, find the new output voltage. **(07 Marks)**

b. Explain the operation step-up chopper with neat diagram and derive an expression for output voltage. **(08 Marks)**

c. Elaborate on the control techniques used in choppers and also give detailed classification of choppers. **(05 Marks)**

Module-3

5 a. With neat circuit diagram and waveforms. Explain the operation of 1ϕ full bridge inverter for RL load. **(07 Marks)**

b. Design a multi range ammeter with range 0-1A, 0-5A and 0-10A employing individual shunt in each a D'Arsonval movement with an internal resistance of 500Ω and full scale deflection of 10mA is available. **(08 Marks)**

c. What are the errors encountered in measurement process? Explain all with suitable example. **(05 Marks)**

OR

6 a. Design modified multirange voltmeter with basic D'Arsonval movement with an internal resistance of 50Ω and full scale deflection of 2mA, with voltage ranges of 0-10V, 0-50V, 0-100V and 0-250V. Draw the schematic diagram and show all values after design. **(07 Marks)**

b. Explain the various static characteristics of measuring instruments. **(08 Marks)**

c. With neat diagram, explain the operation of isolated flyback converter. **(05 Marks)**

Module-4

7 a. With neat block diagram, explain the operation of Ramp type Digital voltmeter. **(07 Marks)**

b. Explain the operation of Time measurement with neat block diagram. **(08 Marks)**

c. Draw the schematic diagram of Wheatstone's bridge and derive an expression for calculating unknown resistance and explain. **(05 Marks)**

OR

8 a. Explain the operation inductance comparision bridge with necessary equations. **(07 Marks)**

b. Discuss the operation of successive approximation type DVM with necessary diagram. **(08 Marks)**

c. An unbalanced Wheatstone bridge shown in Fig.Q.8(c), calculate the current through the galvanometer. **(05 Marks)**

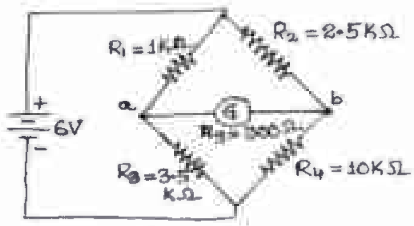

Fig.Q.8(c)

Module-5

9 a. Draw the schematic diagram to measure displacement using resistive transducer and explain. **(07 Marks)**

b. Explain the operation of PLC with neat block diagram. **(05 Marks)**

c. Explain the operation of Instrumentation amplifier using transducer bridge and derive equation for output voltage. **(08 Marks)**

OR

10 a. Explain the construction and working principle of LVDT with characteristic curve. **(07 Marks)**

b. What are factors to be considered for selecting the transducer? **(08 Marks)**

c. Illustrate working of analog weight scale. **(05 Marks)**

* * * * *

Re: Sir, regarding Modification of scheme and solutions (18EC36)

"Mrityunjaya Vithal Latte" <mvlatte@rediffmail.com>

April 8, 2021 9:05 AM

To: "boe" <boe@vtu.ac.in>, "mvlatteBOEVTU" <mvlatte.boe.vtu@gmail.com>

Dear sir,

The scheme of 18EC36 is verified and it is inline with the question paper .
Regards

PROF. MRITYUNJAYA V. LATTE
Principal,
JSS Academy of Technical Education,
Uttarahalli-Kengeri Main Road,Bangalore
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From: boe@vtu.ac.in
Sent: Wed, 31 Mar 2021 10:48:47
To: mvlatte@rediffmail.com, mvlatte25@gmail.com
Subject: Sir, regarding Modification of scheme and solutions (18EC36)

* APPROVED *

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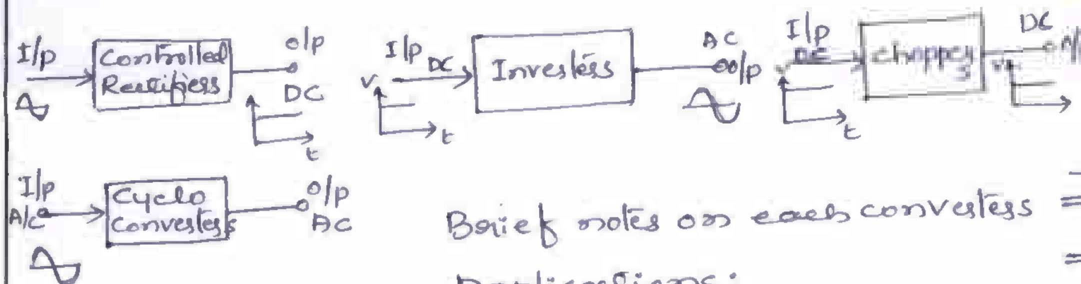
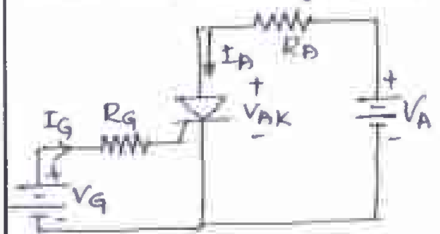
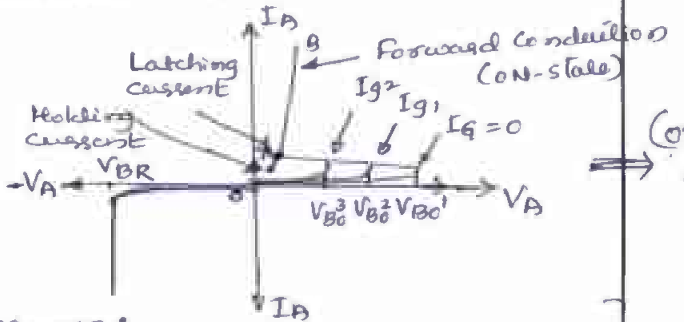
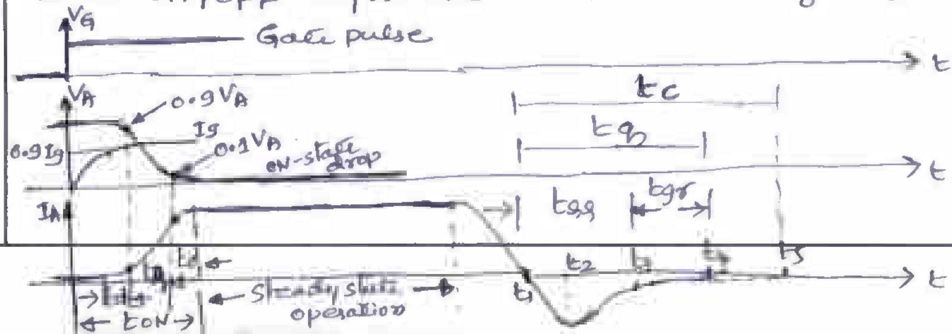
Signature of Scrutinizer

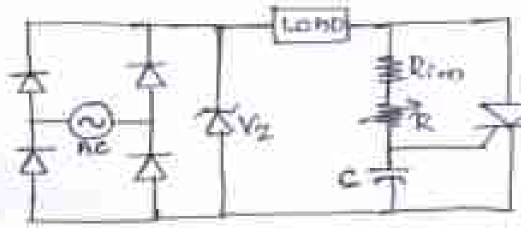
Scheme & Solution

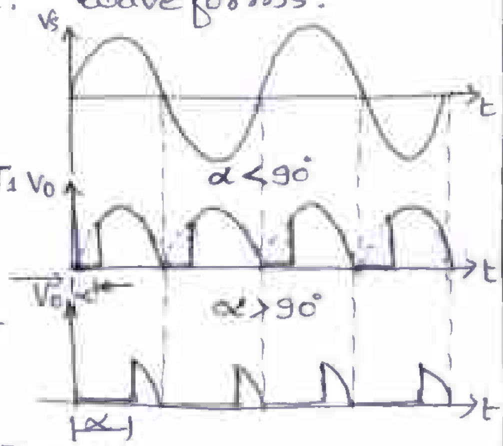
Subject Title : Power Electronics & Instrumentation **Subject Code :** 18EC36.

Question Number	Solution	Marks Allocated
1 (a)	Power Converter Circuits: i) AC to DC ii) DC to AC (Inverters) iii) DC to DC (Choppers) iv) AC to AC v) ~~cycloconverters~~ 	03M
	Brief notes on each converters	⟹ 2M
	Applications; i) SMPS ii) Energy storage system iii) Electrical m/c control iv) Lighting drives v) power generations & distributions vi) Renewable energy conversion vii) Traction control etc	⟹ 2M
(b)	Circuit diagram: 	⟹ (02+02) 04M
	Explanation with reference; i) when $I_g = 0$ and V_A is positive. ii) when I_g = +ve finite value & V_A is positive iii) when $I_g = 0$ and V_A is negative	04 ~~03M~~
(c)	Turn-ON methods; i) Forward Voltage trigger ii) Gate triggering iii) Light triggering iv) Temperature triggering v) dv/dt triggering + Brief note on each	(02+03) 05M
2 (a)	Turn-ON/OFF dynamic characteristics of SCR 	⟹ 03M

Question Number	Solution	Marks Allocated
	Explanation with intervals (time) + Necessary definitions and note on each	⇒ 04M

2. (b) RC Full wave trigger Circuit: wave forms:

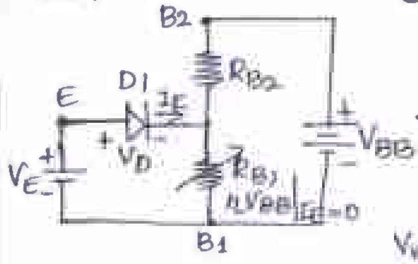




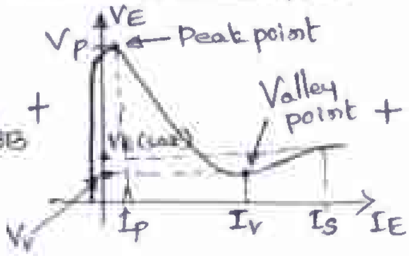
Detailed explanation for $\alpha < 90°$ & $\alpha > 90°$

ckt = 2M, W/F = 2M, Expl = 4M

(c) UJT Circuit : Characteristic curve



\+

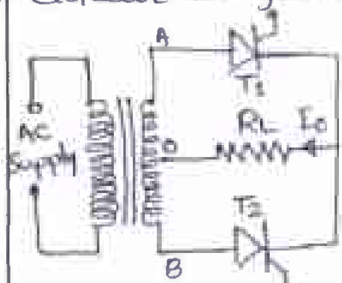


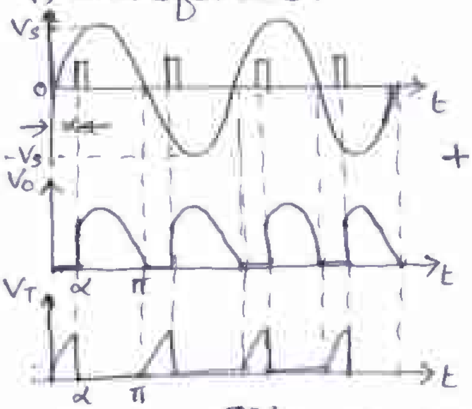
\+ Brief note on operation

1.5M + 1.5M + 2M (Expln) → 05M

Module - 2

3 (a) Circuit diagram: V_s waveforms:





\+ Explanation

2M + 2M + 2M → 06M

Explanation for both cycle

Derivation:

$V_{dc} = \frac{1}{2\pi}\int_\alpha^\pi V_m \sin\omega t \cdot d(\omega t) = \frac{V_m}{\pi}(1+\cos\alpha)$

$I_{dc} = V_{dc}/R_L = V_m/\pi R_L (1+\cos\alpha)$

$V_{orms} = \left[\frac{1}{\pi}\int_\alpha^\pi V_0^2 \, d(\omega t)\right] =$

Efficiency $= \frac{V_{dc}^2}{V_{rms}^2} =$

04M → 10M

(b) Given: $V_s = 230V$; $\alpha = 60°$; $f = 50Hz$; $R_L = 10\Omega$

$V_m = \sqrt{2}V_s = 325.26V$

$V_{dc} = \frac{V_m}{2\pi}\int_\alpha^\pi 1+\cos\alpha =$ ~~103.52 Volts~~ 51.76 Volts — 2M

$V_{rms} = V_m\left[\frac{\pi-\alpha}{4\pi} + \frac{\sin 2\alpha}{8\pi}\right]^{1/2} =$ ~~87.98 Volts~~ 115.99 Volts — 2M

η = efficiency $= V_{dc}^2 / V_{orms} = 51.76^2/115.99^2 \times 100 = 19.91\%$ — 2M

Form factor $= V_{orms}/V_{dc} = 115.99/51.76 = 2.24$ — 2M

Ripple factor $= (FF^2 - 1)^{1/2} = 2.00$ — 2M

→ 10M

Question Number	Solution	Marks Allocated

4 (a) Given: $V = 200$ Volts $t_{ON} = 200\mu s$ $V_{odc} = 600$ Volts

$\therefore V_{odc} = V \times \left(T/_{T-t_{ON}}\right)$ $600 = 200\left(\frac{T}{T-200\mu s}\right)$ $\therefore T = 300\mu s$ ⇒ 2M

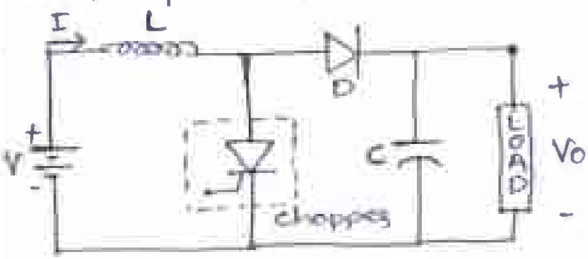
$\therefore$ chopping frequency $= f = 1/T = 1/300\mu s = 3.33KHz$ ⇒ 2M

If pulse width is halved $\therefore t_{ON} = \frac{200\mu s}{2} = 100\mu s$ ⟹ 1M

$\therefore$ New o/p Voltage $= V'_{odc} = V\left(\frac{T}{T-t_{ON}}\right) = 200\left(\frac{300\mu s}{300\mu s - 100\mu s}\right)$

$V'_{odc} = 300$ Volts ⟹ 2M

(b) step-up chopper Circuit:



+ Detailed explanation + Derivation ⟹ 2M

ckt - 2M, Expl - 3M } 5M

when chopper is ON;
Voltage a/c inductor $L = V$ $\therefore$ energy A/c $L = V I t_{ON}$
when chopper is OFF
Voltage a/c Inductor $L = V_o - V$ $\therefore$ Energy A/c $L = (V_o - V) I t_{off}$

$\therefore V I t_{ON} = (V_o - V) I t_{OFF}$

$\therefore V_o = V\left(T/_{T-t_{ON}}\right)$ where $T = t_{ON} + t_{off}$

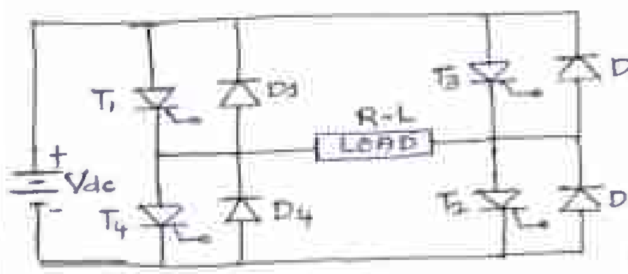
$\therefore V_o = V\left(1/_{1-\delta}\right)$ } 3M

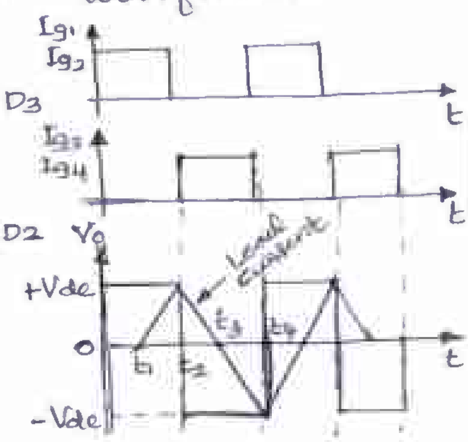
(c) Techniques used in choppers
i) Pulse width modulation control
ii) Variable frequency control
+ brief notes with diagram 3M

Detailed chopper classification ⟹ 2M.

Module - 3

5 (a) 1ϕ Full bridge Inverter ckt: waveforms:

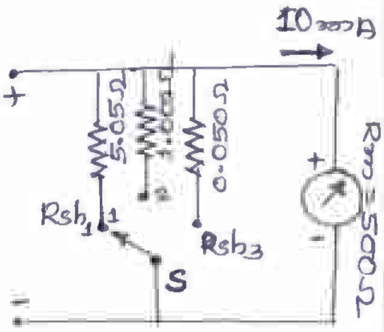
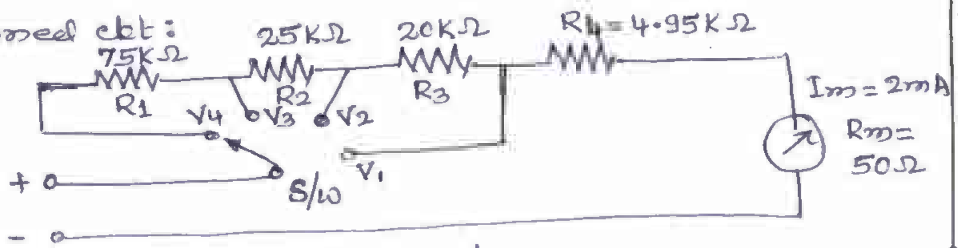




ckt = 2M, w/f = 2M, Expl^n = 3M } 07M

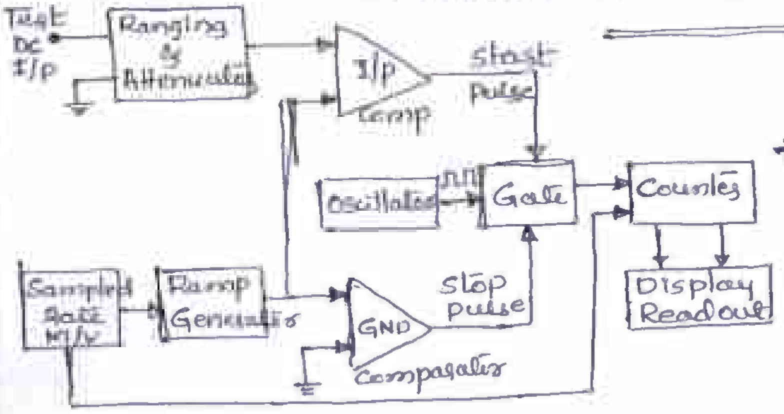
Detailed operation of circuit ⟹ (3M)

Subject Title : Power Electronics & Instrumentation **Subject Code :** 18EC36

Question Number	Solution	Marks Allocated
5 (b)	Given: $I_m = 10mA$; $R_m = 500\Omega$ We know that: $R_{sh} = \frac{I_m R_m}{I - I_m}$ ∴ case 1: 0 – 1A. i.e $R_{sh_1} = \frac{10mA \times 500}{1A - 10mA} = 5.05\Omega$ ∴ case 2: 0 – 5A $R_{sh_2} = \frac{10mA \times 500\Omega}{5A - 10mA} = 1.002\Omega$ ∴ case 3: 0 – 10A. $R_{sh_3} = \frac{10mA \times 500\Omega}{10A - 10mA} = 0.050\Omega$ 	Design: 06M Circuit: 2M 08M
(c)	Errors Encountered in Measurements are; 1) Gross Error 2) Systematic Error 3) Random errors + Brief note on each with Example	01M + 04M 05M
6 (a)	Given: $R_m = 50\Omega$ $I_m = 2mA$. Case 1: For 10V range $R_t = V/I_{fsD} = \frac{10V}{2mA} = 5K\Omega$ ∴ $R_4 = R_t - R_m = 5K - 50 = 4.95K\Omega$ Case 2: For 50V Range $R_t = V/I_m = \frac{50V}{2mA} = 25K\Omega$ ∴ $R_3 = R_t - (R_4 + R_m) = 25K - (4950 + 50) = 20K\Omega$ Case 3: For 100V Range; $R_t = 100/2mA = 50K\Omega$ ∴ $R_2 = R_t - (R_3 + R_4 + R_m) = (50K - (20K + 4950 + 50)) = 25K\Omega$ Case 4: For 250V $R_t = 250/2mA = 125K\Omega$. ∴ $R_1 = R_t - (R_2 + R_3 + R_4 + R_m) = 75K\Omega$ Designed ckt: 	05M 2M
(b)	Static characteristics of Instruments: i) Accuracy ii) Precision iii) Resolution iv) Sensitivity v) Repeatability vi) Expected Value + Brief note on each characteristics ⟹ 6M	2M 6M
(c)	Circuit diagram of Hybrid converter ⟹ 2M Explanation ⟹ 3M	2M 3M

Question Number	Solution	Marks Allocated
	Module – IV	

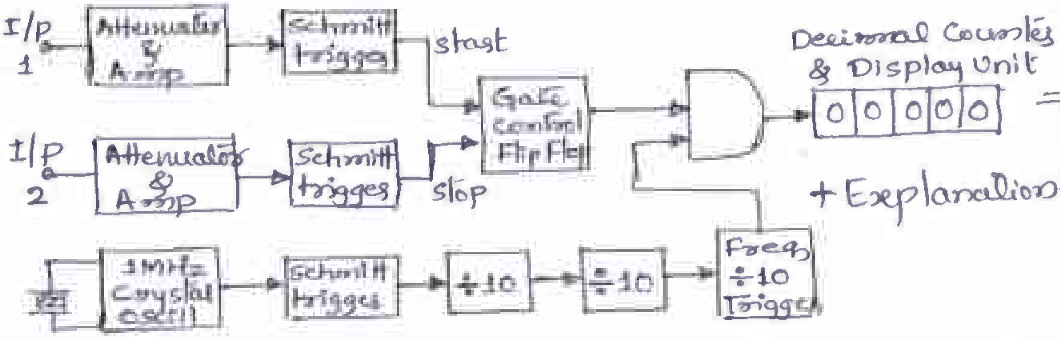
7 (a)



→ 03M

+ Explanation ⇒ 04M

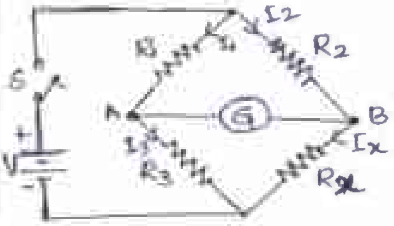
(b)



⇒ 04M

+ Explanation ⇒ 04M

(c) Wheatstone Circuit



To have bridge balance equation

$I_1 R_1 = I_2 R_2$

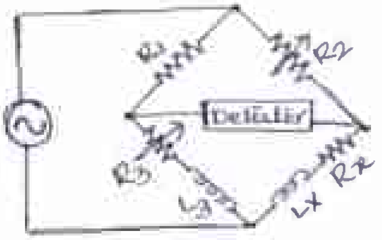
$\therefore I_1 = I_3 = E / R_1 + R_3$

$\therefore I_2 = I_x = E / R_2 + R_x$

$\therefore \frac{E R_1}{R_1 + R_3} = \frac{E R_2}{R_2 + R_x} \quad \therefore R_x = \frac{R_2 R_3}{R_1}$

ckt = 1M, Proof = 2M, Expl^n = 2M } 05 M

8 (a) Inductance comparision bridge



Balance Condition

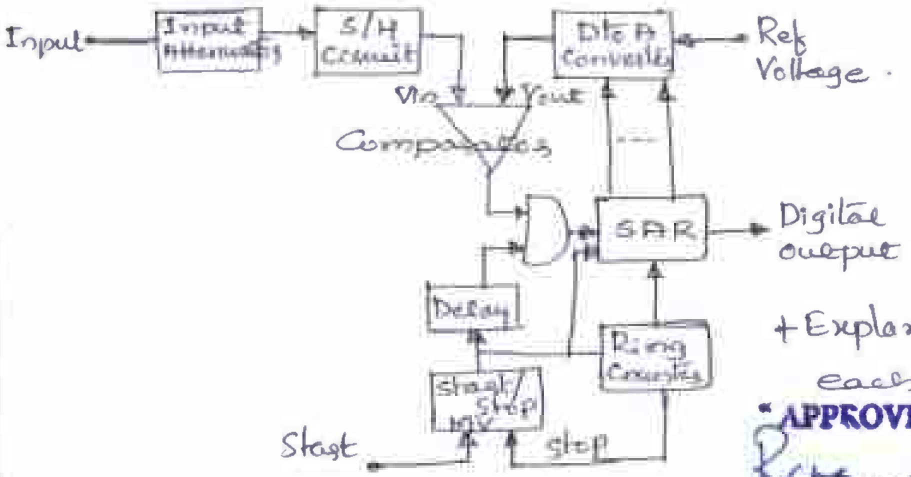
$Z_1 Z_x = Z_2 Z_3 \quad \therefore L_x = \frac{R_2}{R_1} L_3$

$R_x = \frac{R_2 R_3}{R_1}$

+ Brief explanation

ckt = 2M, eqn's = 2M, Expl^n = 3M } 07 M

(b)



ckt = 03M

+ Explanation of each block ⇒ 05M

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Q.8.c $E_{th} = E_a - E_b = E\left(\frac{R_4}{R_2+R_4} - \frac{R_3}{R_1+R_3}\right) = 0.132\ \text{Volts}$ ⟹ 02M

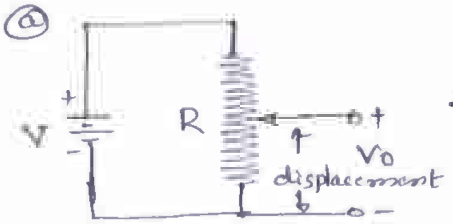
$= E_b - E_a'$

$R_{th} = \frac{R_1 R_3}{R_1+R_3} + \frac{R_2 R_4}{R_2+R_4} = 2.778\,K\Omega$ ⟹ 2M

$\therefore I_g = R_{th}/R_{th}+R_g = 0.132/2.77K+0.3K = 42.88\,\mu A$ ⟹ 01M

Module-5

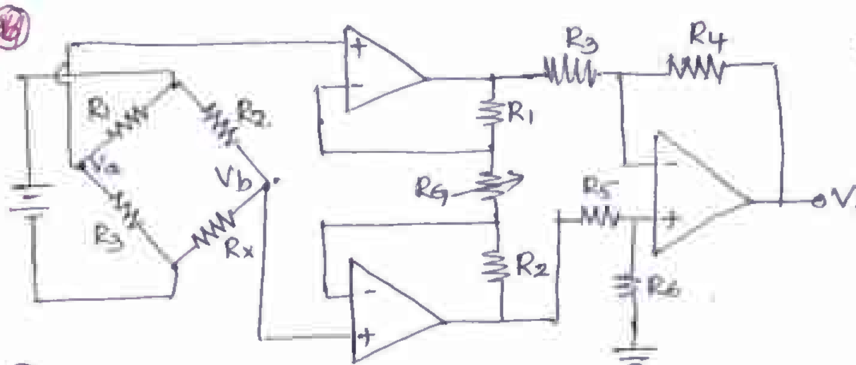
Q.9 (a)



+ Necessary Explanation with mathematical equation ⟹ 02+05=07M

(b) Block diagram of PLC + Explanation ⟹ 02+03 = 05M

(c)

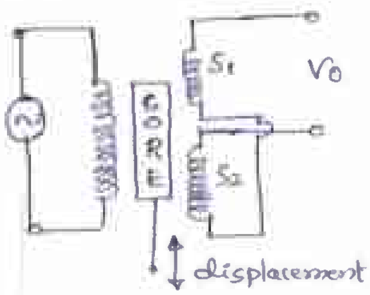


⟹ ckt = 3M

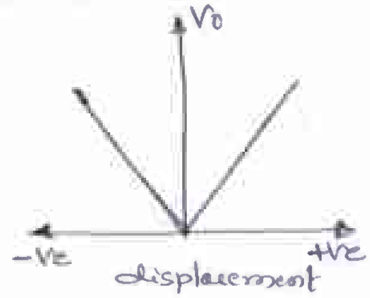
Explanation ⟹ 2M

Derivation for Vo o/p equation ⟹ 03M

Q.10 (a) Construction:



Characteristic Curve:



⟹ 02M

Construction Explanation ⟹ 02M

Operation Explanation ⟹ 03M

(b) Factors for selecting transducers

i) operating range ii) Accuracy iii) Sensitivity

iv) Ruggedness v) Stability vi) static characteristics

vii) Loading effect + short notes on each

} 08M

(c) Analog weight Block diagram with PLC ⟹ 2M

Explanation ⟹ 03M

——— o ———