EE 392 TUTORIAL

November 2006 Ref: 1/2/2006

Question 1

A beam, which is supported through pin joints at its ends, is acted upon by a couple M in a plane containing the axis of the beam, applied at a point two thirds of the span from one end. Find expressions for the slope of the beam at both ends, and the maximum deflection.

Regina T. Nyirongo

done

Question 2

Compare the weights of equal lengths of hollow and solid shaft to transmit a given torque for the same maximum shear stress, if inside diameter is ¾ of the outside. done

Question 3

You have been commissioned to design the suspension for a new light truck. The net weight of the light truck up is 3000kg, distributed 38% on the rear axle and 62% on the front axle. When fully loaded an additional 5000kg is added to the light truck, distributed 75% on the rear axle and 25% on the front axle. You are using, on the front axle 2 identical helical close coiled springs in parallel, and on the rear axle 2 identical leaf springs in parallel. Your design constraint is, completely unloaded to fully loaded, the maximum static deflection on either axle should not exceed 15 cm. given for:

Helical spring:

Mean coiled diameter	=	25cm
Modulus of rigidity	=	83.5 GN/m^2
Wire diameter	=	35mm

done

Regina T. Nyirongo

Leaf spring:

Length	=	1 m
Number of leaves	=	6
Width to thickness ratio	=	8:1
Elastic modulus	=	125 GN/m^2

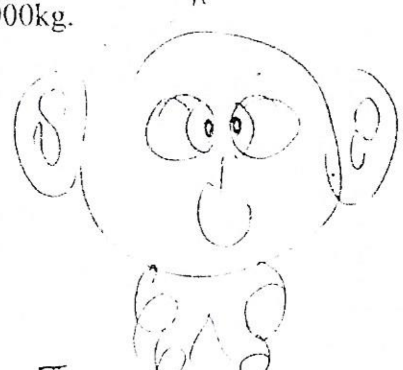
Find:

(a) the number of coils required in the helical springs (5 marks)

(b) the width of the leaf springs (5 marks)

(c) the deflection at both axles when acted upon by the net weight of the pickup only. (4 marks)

(d) If the distance between the rear and front axle is 6 m what is the magnitude and direction of the shift in the centre of gravity of the pickup when loaded with the additional 5000kg. (6 marks)



$\varepsilon = \frac{L}{L_c}$

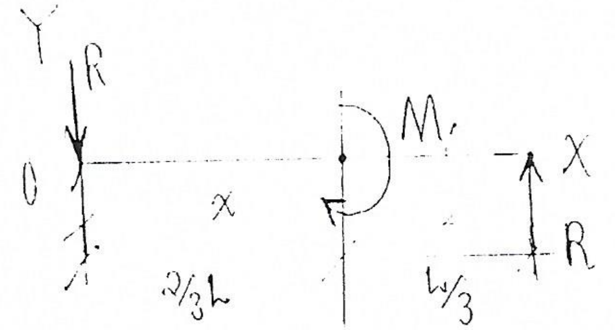
student Engineer JERRY ZEE

BEng, MEng, REng, MEIZ, PhD

SOLUTIONS TO TUTORIALS

BE 392 (2006) NOVEMBER.

QUESTION 1



$RL = M;$

$\boxed{R = \frac{M}{L}}$

Moment; $M_x = ?$

$$EI\frac{d^2y}{dx^2} = M_x = -Rx + M\left[x - \frac{2L}{3}\right]^0$$

$$EI\frac{dy}{dx} = -\left(\frac{R}{2}\right)x^2 + M\left(x - \frac{2L}{3}\right) + A$$

$$EI\,y = -\left(\frac{R}{6}\right)x^3 + \frac{M}{2}\left(x - \frac{2L}{3}\right)^2 + Ax + B$$

Applying BC's

$x = 0;\ y = 0;$ $\quad 0 = -\left(\frac{R}{6}\right)0 + A(0) + B;\ \boxed{B = 0}$

$x = L;\ y = 0;$ $\quad 0 = -\left(\frac{R}{6}\right)L^3 + \frac{M}{2}\left(\frac{L}{3}\right)^2 + AL + 0$

$$\Rightarrow AL = \left(\frac{M}{6L}\right)L^3 - \frac{ML^2}{18} = \frac{(3-1)ML^2}{18}$$

$$\therefore \boxed{A = \frac{ML}{9}}$$

at $x = 0;$ $EI\frac{dy}{dx} = -\left(\frac{R}{2}\right)x^2 + \frac{ML}{9} \Rightarrow EI\frac{dy}{dx} = \frac{ML}{9},$

i.e. $\boxed{\frac{dy}{dx} = \frac{ML}{9EI}}$ done. $\quad L - \frac{2L}{3} \; = \frac{L^2}{9}$

~~at $x = L;$ $EI\frac{dy}{dx} = -\left(\frac{M}{6L}\right)x^3 + \frac{M}{2}\left(x - \frac{2L}{3}\right)^2 + \left(\frac{ML}{9}\right)x$~~

cancelled

$\Rightarrow EI\frac{dy}{dx} = -\frac{ML^2}{6} + \frac{ML^2}{18} + \frac{ML^2}{9} - \frac{\cdots}{18}$

$x = L$; $EI\frac{dy}{dx} = -\left(\frac{M}{2L}\right)x^2 + M\left[x - \frac{3L}{2}\right] + \frac{ML}{9}$

$EI\frac{dy}{dx} = -\frac{ML}{2} + \frac{ML}{3} + \frac{ML}{9} = \left(\frac{-9+6+2}{18}\right)ML$

$EI\frac{dy}{dx} = -\frac{ML}{18}$; $\boxed{\frac{dy}{dx} = \frac{-ML}{18EI}}$

Maximum deflection shall be at

$x < \left(\frac{3}{2}\right)L$; $\frac{dy}{dx} = 0$ at the point.

$0 = -\frac{Rx^2}{2} + \frac{ML}{9}$; $x^2 = \left(\frac{2}{9}\right)\frac{ML}{R} = \left(\frac{2}{9}\right)\frac{ML}{\frac{M}{L}} = \left(\frac{2}{9}\right)L^2$

$\Rightarrow \boxed{x = \frac{\sqrt{2}}{3}L}$ done.

Regina T. Nyerongo

at $x = \frac{\sqrt{2}}{3}L$

$EIy = -\left(\frac{R}{6}\right)x^3 + \left(\frac{ML}{9}\right)x$;

$EIy = -\left(\frac{M}{6L}\right)\left(\frac{\sqrt{2}}{3}L\right)^3 + \left(\frac{ML}{9}\right)\left(\frac{\sqrt{2}}{3}L\right) = \left(-\frac{2\sqrt{2}L^2}{2(3)(3^3)} + \frac{L^2\sqrt{2}}{27}\right)M$

$EIy = +\frac{\sqrt{2}ML^2}{1}\left(\frac{-1+3}{81}\right)$; $\boxed{y = +\frac{2\sqrt{2}ML^2}{81}}$

$\therefore \boxed{y = \frac{2\sqrt{2}ML^2}{81}}$ done.

$$\frac{T}{J} = \frac{\hat{\tau}}{r} = \frac{G\theta}{L} \quad \text{—(i)}; \qquad \frac{T}{\hat{\tau}} = \frac{2J}{D} \quad \text{—(ii)} \quad \left(r = \frac{D}{2}\right)$$

Solid shaft:

$$J = \frac{\pi D^4}{32}, \quad \frac{T}{\hat{\tau}} = 2\left(\frac{\pi}{32}D^4\right)\left(\frac{1}{D}\right) = \frac{\pi D^3}{16} \quad \text{—(iii)}$$

Hollow ~~cylinder~~ Shaft.

$$\frac{T}{\hat{\tau}} = \frac{2}{D_1}\left(\frac{\pi\left(D_1^4 - d^4\right)}{32}\right) \quad ; \text{ But } \boxed{d = \frac{3}{4}D_1}$$

$$\Rightarrow \frac{T}{\hat{\tau}} = \left(\frac{\pi}{16 D_1}\right)\left[D_1^4 - \left(\tfrac{3}{4}D_1\right)^4\right] = \frac{\pi D_1^3}{16}\left(\frac{175}{256}\right) \quad \text{—(iv)}$$

equating eqn (iii and iv)

$$\frac{\pi D^3}{16} = \frac{\pi D_1^3}{16}\left(\frac{175}{256}\right); \quad D_1^3 = \left(\frac{256}{175}\right)D^3; \quad D_1 = D\sqrt[3]{\left(\frac{256}{175}\right)}$$

$$\Rightarrow \boxed{D_1 = 1.1352\,D}$$ database

Ratio of weights ; $w = \rho g V = \rho g\left(\frac{\pi D^2}{4}\right)L$ solid shaft.

$= \rho g V = \rho g\left[\frac{\pi}{4}\left(D_1^2 - d^2\right)\right]L$ hollow shaft.

$$\Rightarrow \text{Ratio} = \frac{\left(D_1^2 - d^2\right)}{D^2}\left(\frac{\rho g \frac{\pi L}{4}}{\rho g \frac{\pi L}{4}}\right) = \left(\frac{D_1^2 - \left(\frac{3}{4}\right)^2 D_1^2}{D^2}\right) = \left(\frac{D_1}{D}\right)^2\left(1 - \frac{9}{16}\right)$$

$$\text{Ratio of weights} = \left(\frac{7}{16}\right)\left(\frac{D_1}{D}\right)^2 = \left(\frac{7}{16}\right)(1.1352)^2$$

$$= \underbrace{0.5638}$$ done.

QUESTION 3

	Weight	%JF	%JR	FRONT axle	Rear axle
WA	3000kg	62%	38%	1860	1140
LOAD	5000kg	25%	75%	1250	3750
Total				3110	4890
in Newtons.				30 509.1	47 970.9
One side				15 254.55	23,985.45

deflection $= \delta = 15cm = 0.15\,m$.   Regina . T. Alyirongo

(a) $\frac{8WD}{\pi d^4} = \frac{\hat{c}}{d} = \frac{Gx}{\pi D^2 n}$; $n = \frac{Gx \cancel{\pi} d^4}{\cancel{\pi} 8WD^3} = \frac{G(x)d^4}{8WD^3}$

$$n = \frac{(83.5 \times 10^9)(0.15)(0.035)^4}{8(15\,254.55)(0.25)^3} = 9.856.$$

for x not to exceed 15cm; $\boxed{n = 9 \text{ coils}}$ [5 marks]

$$x = \frac{8WD^3 n}{Gd^4} = \frac{8(15254.55)(0.25^3)(9)}{(83.5 \times 10^9)(0.035)^4} ; \boxed{x = 0.137\,m}$$

(c) (i) $W_a = \frac{(9.81)(1860)}{2} = 9123.3[N]$

$$x = \frac{8W_a D^3 n}{Gd^4} ; \quad x = \frac{(8)(9123.3)(0.25^3)(9)}{(83.5 \times 10^9)(0.035)^4} ;$$

$\boxed{x = 0.0819\,m}$ correct.

1(b)

$K = \frac{W}{\delta}$

$\frac{1}{2} T\theta$

$\frac{1}{4C} \tau^2 \cdot Vol_{(wire)}$

Helical

$d = 12mm$

$R = 60mm$

$n = 10$

$K = ?$

spring constant

stiffness

$K = \frac{W}{\delta}$

$\delta = R\theta$

$\frac{T}{I_P} = \frac{C\theta}{L}$

$\frac{TL}{CI_P} = \theta$

$\frac{WR \, 2\pi R n \, 32}{C \pi d^4}$

$\theta = \frac{64WR^2 n}{Cd^4}$

$K = \frac{Cd^4}{64R^3 n}$

$K = \frac{W}{\delta}$

(b) $\delta = y_0 - y = \left(\frac{3}{8}\right)\frac{WL^3}{nbt^3E}$; $\frac{b}{t} = \frac{8}{1}$; $\boxed{b = 8t}$ $\boxed{t = \frac{b}{8}}$

$$\delta\left(\frac{b}{8}\right)^3 b = \frac{3}{8}\frac{WL^3}{nE} ; \quad \boxed{b^4 = \frac{3(8)^2 WL^3}{\delta n E}}$$

$$b^4 = \frac{3(8)^2(23\,985.45)(1)^3}{(0.15)(6)(125\times10^9)} ; \quad b^4 = 4.0935\times10^{-05}.$$

$b = 0.07999$; $\boxed{b = 0.08\ m}$ done. [5 marks]

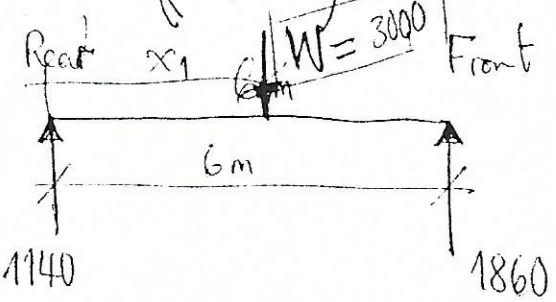
Regina T. Nyirongo

c(ii) $W_b = \frac{(1140\times9.81)}{2} = 5591.7\ N$.

$$\delta = \frac{(3)(5591.7)(1^3)}{(8)(6)\left(\frac{(0.08)^4}{8^3}\right)(125\times10^9)} ; \quad \boxed{\delta = 0.03495\ m}$$ too right

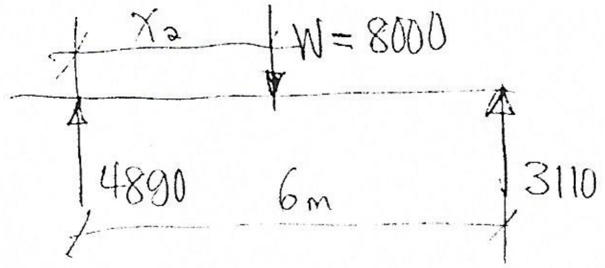
[4 marks]

(d)



$3000x = 1860(6)$

$\boxed{x_1 = 3.72\ m}$



$8000x = 3110(6)$

$\boxed{x = 2.33\ m}$

$x_1 - x_2 = (3.72 - 2.33) = \underline{1.39\ m}$ too too right

towards the rear axle.

$\phi = \frac{mm'}{l} = \frac{R\theta}{l} = \frac{\tau}{C}$ $\cdot \frac{n}{60}$

perf. of material
resist twist.

rev/min

$P = T2\pi N$

$\phi = \frac{mm'}{l} = \frac{R\theta}{l} = \frac{\tau}{C}$

$P = T2\pi N$

$P = 25kW$

$N = 200$ r.p.m $= \frac{n}{60}$

$T = F.R$

$D = ?$ Shaft — Solid — Hollow

$l = 2$

$\theta = \frac{\pi}{180} = 0.017$ Rd

Rad =

$\pi = 180°$

$x - 1°$

$P = T2\pi N$

$\frac{P}{2\pi N} = T$

$N = \frac{n}{60}$

$\frac{\pi}{32} d^4$ $l = 2\pi R n$

$\phi = \frac{mm'}{l} = \frac{R\theta}{l} = \frac{\tau}{C}$

$\boxed{P = T2\pi N}$ τ

$\frac{\tau}{R} = \frac{C\theta}{l} = \frac{T}{I_p}$

Comparison

- Absorb shocks.
- apply and control motions.
- Store Energy

$\frac{T}{I_p} = \frac{\tau}{R} = \frac{C\theta}{l}$

twist.

$\frac{P}{2\pi N I_p} = \frac{\tau}{R}$ $\frac{T}{I_p} = \frac{\tau}{R} = \frac{C\theta}{l}$

$R = \frac{\tau 2\pi N I_p}{P}$

$D = \frac{4\tau\pi N I_p}{P}$

$1 \cancel{D} = 4 \times 50 \times 10^6 \times \pi \times \frac{20\cancel{0}}{6\cancel{0}\cancel{0}} \times \frac{\pi}{32} D^4$

$1 = D^5$

590.2

$\tau_{max} = 1.2 \tau_{mean}$

d D
3 : 8

20% greater than the mean

$8d = 3D$ $T = 2.2 kNm$

deflection

stiffness of the spring

$k = \frac{W}{\delta}$

$U = \frac{1}{2} T\theta$

$\frac{T}{I_p} = \frac{\tau}{R} = \frac{C\theta}{l}$

$\tan\theta = \frac{\delta}{R}$

$R\theta = \delta$

$\frac{T}{I_p} = \frac{C\theta}{l}$

$\frac{TL}{CI_p} = \theta$

$\frac{WR \, 2\pi R n \, 32}{C \pi d^4}$

$T = WR$

Question 8

A solid 1m shaft of radius 90 mm and density 6 g/cm^3 carries 4 unbalanced masses spaced as follows:

Masses A, B, C, and D are 11, 7, 10, and 13kg respectively, rotating at radii 10, 8, 9, 7cm respectively, and spaced from one end of the shaft at 20, 40, 60, and 80 cm respectively. the angular spacing from A to B, C, and D are 120, 200, and 300° respectively.

(a) Balance the shaft using two 5 kg masses at either end (9 marks)

(b) If before balancing, the shaft rotated at 600 rpm what will be its rotation after balancing. (5 marks)

(c) If all masses are removed from the shaft and the power transmitted is 12 kW, determine the maximum shear stress on the shaft. (6 marks)

Note: Uniform disc or cylinder, radius r. I about the central axis is $\frac{mr^2}{2}$ and $k = \frac{r}{\sqrt{2}}$

Regina . T. Alyerner

Question 9

You are designing the spring damper system for a 1850 kg 4X4 Luxury vehicle. The test road is sinusodially undulated with a maximum displacement of 36cm. If the maximum allowable displacement of the vehicle relative to the road is 42cm, determine:

(a) the damping ratio and state whether it is over, critically or under damped (5 marks)

If the length of one undulation is 2m, and the damping coefficient is 9500kg/s, determine:

(b) the stiffness of the suspension (4 marks)

(c) the speed in km/h of the vehicle at maximum displacement (5 marks)

(d) the maximum displacement of the vehicle if the ~~and~~ the vehicle is moving at 140km/h (6 marks)

$\omega = T \cdot 2\pi n$

$\frac{12000 = T \cdot 2\pi}{2\pi \times 93.26}$

$K = \frac{Mr^2}{2}$

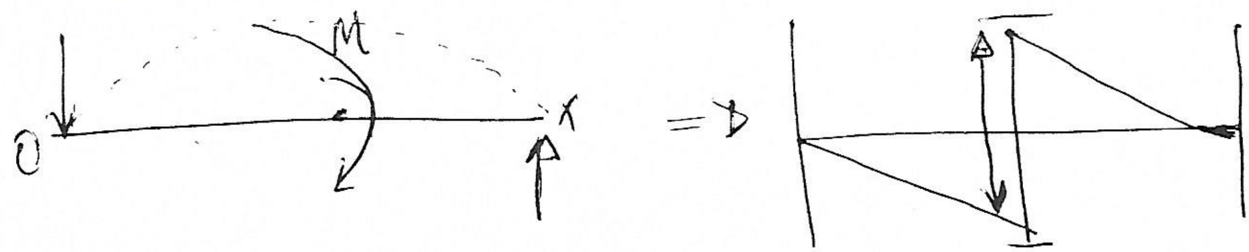
I

618.35 kg m^{-2}

turns/min x 60

turns/s

Question 1



Since Force must be equal and opposite, then the moments about O (M+)

$$M - RL = 0$$

$$R = \frac{M}{L}$$

It follows that

$$EI\frac{d^2y}{dx^2} = -Rx + M\left[x - \frac{2L}{3}\right]^0$$

$$EI\frac{dy}{dx} = -\frac{R}{2}x^2 + M\left[x - \frac{2L}{3}\right] + A$$

$$EIy = -\frac{Rx^3}{6} + \frac{M}{2}\left[x - \frac{2L}{3}\right]^2 + Ax + B.$$

Boundary conditions

$x = 0,\ y = 0$ . . . . (i)

$x = L$ at $y = 0$ . . . (ii)

Using the first boundary condition $B = 0$.

Using the second boundary condition.

$$AL = \frac{RL^3}{6} - \left(\frac{M}{2}\right)\left(\frac{L}{3}\right)^2$$

$$= \frac{ML^3}{L6} - \frac{ML^2}{18} \Rightarrow \frac{ML^2}{6} - \frac{ML^2}{18}$$

$$A = \frac{ML}{9}$$ //

At $x = \frac{2L}{3}$

$$EI\frac{dy}{dx} = \left(-\frac{R}{2}\right)\left(\frac{2L}{3}\right)^2 + \frac{ML}{9}$$

$$EI\frac{dy}{dx} = \frac{-ML}{9}$$

Slope = $\frac{dy}{dx} = \frac{-ML}{9EI}$ and pointing downwards to the right.

Deflection = y = $EIy = -\left(R/_6\right)\left(\frac{2L}{3}\right)^3 + \left(\frac{ML}{9}\right)\left(\frac{2L}{3}\right)$

$$y = \frac{2ML^2}{81EI} \text{ upwards}$$

For $x < \frac{2L}{3}$ (a point of zero slope must exist.

$$-\frac{Rx^2}{2} + A = 0$$

$$x = \left(\frac{\sqrt{2}}{3}\right)L$$

∴ the maximum deflection = $\dfrac{\left[-\left(\frac{M}{6L}\right)\left(\frac{2\sqrt{2}}{27}\right)L^3 + \left(\frac{ML}{9}\right)\left(\frac{\sqrt{2}}{3}\right)L\right]}{EI}$

Max deflection = $\dfrac{2\sqrt{2}\,ML^2}{81\,EI}$

Question 2

$d = \frac{3}{4} D$

J for a solid shaft $= \frac{\pi D^4}{32}$

J for a hallow shaft $= \frac{\pi (D^4 - d^4)}{32}$

$$\frac{T}{\tau} = \frac{\pi}{32} (D^4 - d^4) \frac{2}{D_i}$$

$$\cancel{\frac{T}{\tau}} = \frac{\pi}{16 D} (D^4 - d^4)$$

$$= \frac{\pi D_i^3}{16} \left(1 - \frac{81}{256}\right)$$

$$= \frac{\pi D_i^3}{16} \left(\frac{175}{256}\right)$$

equating Diameters

$$\frac{\pi D^3}{16} = \frac{\pi D_i^3}{16} \left(\frac{175}{256}\right)$$

$D_i = D\,1.1352$

$$D = D_i \sqrt[3]{\frac{175}{256}}$$

$$\underline{\underline{D = D_i\, 0.881}}$$

ratio of weights equal length

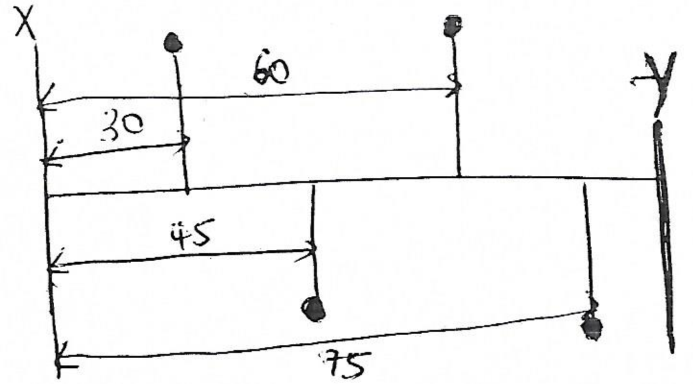
$$\frac{D_1^2 - d^2}{D^2}$$

$$\left(\frac{D_1}{D}\right)\left(1 - \frac{9}{10}\right)$$

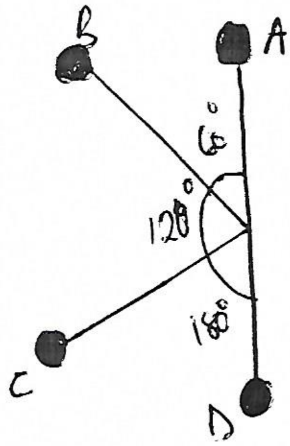
$$(1.352)^2 \left(\frac{16-9}{10}\right)$$

$$= 0.5637$$

Question 3



Distances in cm.



	M	r	Mr	x	Mrx	mrx cos θ	mrx sin θ
X	M_1	r_1	Mr_1	0	0	0	0
A	10	0.12	1.2	0.30	0.36	0.36	0
B	12	0.10	1.2	0.45	0.54	0.27	0.467
C	10	0.12	1.2	0.60	0.72	−0.36	0.624
D	12	0.10	1.2	0.75	0.9	−0.90	0
Y	11	r_2	$11r_2$	2.00	$22r_2$	$22r_2\cos\theta$	$22r_2\sin\theta$

$$\Sigma M_r x \cos\theta = -0.63$$

$$\Sigma M_r x \sin\theta = 1.091$$

$$R = \sqrt{(0.63)^2 + (1.091)^2}$$

$$R = 1.260 \qquad \theta = \tan^{-1}\left(\frac{1.091}{-0.63}\right)$$

$$\theta = -60^\circ$$

$$\frac{22r_2}{22} = \frac{1.260}{22}$$

$$r_2 = 0.0573\,m$$

On the y plane, 11 kg should be placed

at a radius of 5.73cm at the angle of 300°

A.

	Mr	Mr Cos θ	Mr Sin θ
X	11r1	0	0
A	1.2	1.2	0
B	1.2	0.6	1.04
C	1.2	-0.6	1.04
D	1.2	-1.2	0
Y	0.63	0.32	~~+~~0.55

$\Sigma M_r \cos\theta = 0.32$ $\quad \Sigma mr\sin\theta = 1.53$

$11r_1 = \sqrt{(0.32)^2 + (1.53)^2}$

$= \sqrt{2.4433}$

$11r_1 = 1.563$ $\quad \theta = \tan^{-1}\left(\frac{1.53}{0.32}\right)$

$\frac{11r_1}{11} = \frac{1.563}{11}$ $\quad \theta = 258.19°$

$r_1 = 0.142m$

$r_1 = 14.21\,cm$

∴ the 11 kg mass must be placed at a radius of 14.21 cm ~~from~~ and at 258.19° from A.

$M_1 r_1 \omega^2 = M_2 r_2 \omega^2$

$4.8(2000)^2 = 6.993(\omega_2)^2$

$\underline{\omega = 1656.97 \text{ rpm}}$

c) $I = \frac{Mr^2}{2}$ $K = \frac{r}{\sqrt{2}}$

LATE

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 3112 - ELECTRICAL ENGINEERING PRACTISE

ASSIGNMENT ONE

$= \frac{0}{40} + \frac{0}{40} = \frac{0}{80}$

NAME: PATEL ARJUN

COMPUTER NO: 13064177

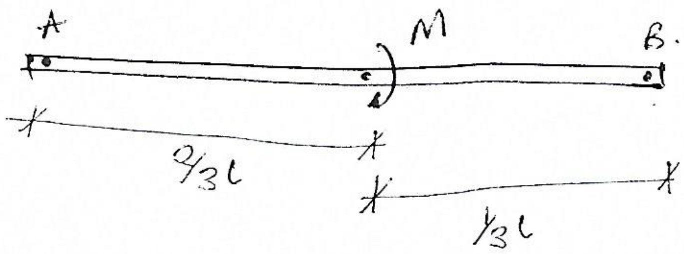
LECTURER: MR. GOMA

$\frac{20}{40}$ $\frac{2}{4}$ $= \frac{1}{2}$

Greg - berg - transp

Lazio Manzeny
A - A = 8

Question 1



78
72
55
54

$\Sigma M_A = 0.$

$M = R_B l.$

$R_B = \frac{M}{l}.$

$\Sigma F_y = 0$

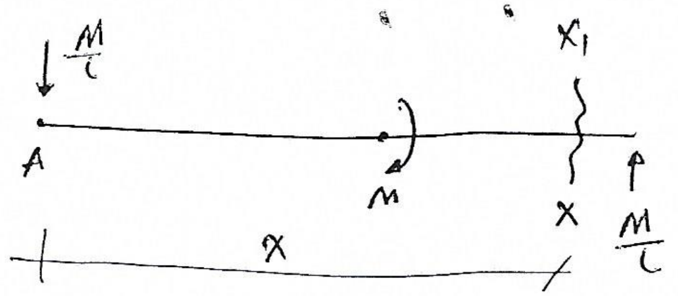
$R_B = \frac{M}{l} = -R_A = \frac{M}{l}.$ 51.

42;42

30

20

6

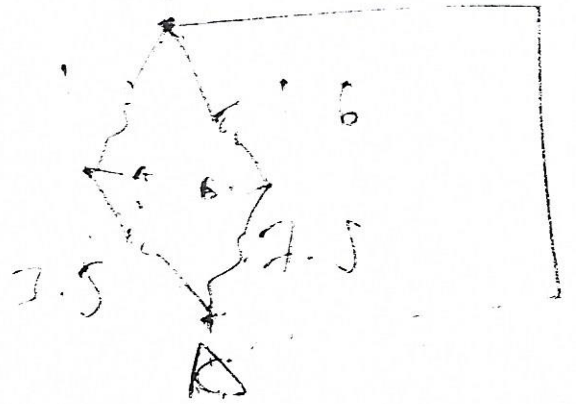


Considering a section on the right at XX' of length x

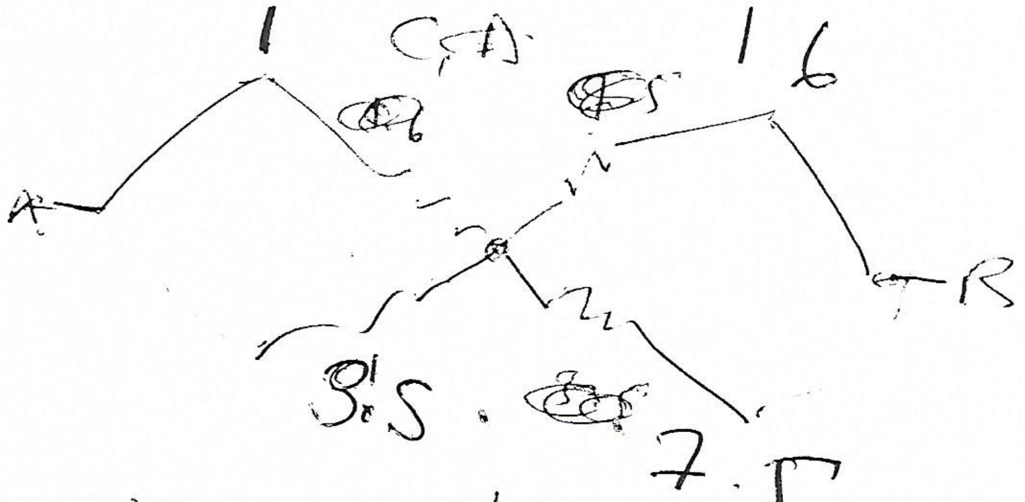
$$EI\frac{d^2y}{d^2x} = M. \qquad M = -\frac{M}{l}x + M(x - \tfrac{2}{3}l)^0.$$

$$EI\frac{d^2y}{d^2x} = -\frac{Mx}{l} + M(x - \tfrac{2}{3}l)^0$$

$$EI\frac{dy}{dx} = -\frac{Mx^2}{2l} + M(x - \tfrac{2}{3}l)^1 + C$$

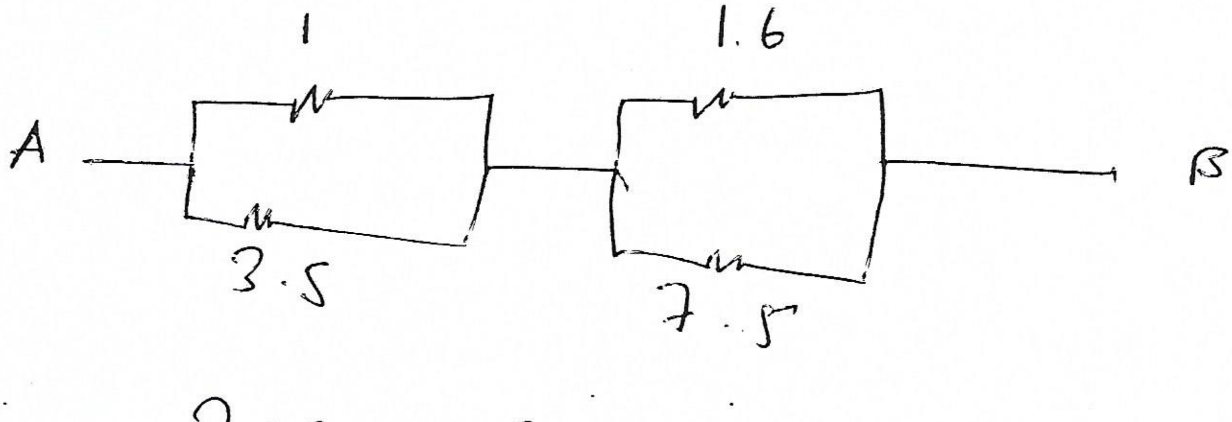


$\underline{1.2\,mA}$



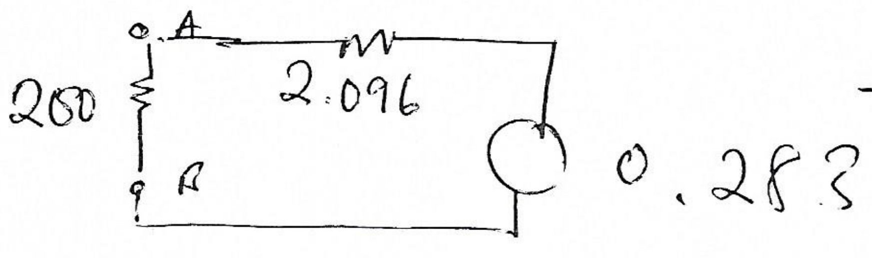
~~$R_{AB} = 1.6 \parallel 1 + 3.5 \parallel 7.5$~~

$1 \parallel 3.5$



$2.096 = R_{TH}$

$\underline{1.2 \times 10^{-4}\,A}$



$$EIy = -\frac{Mx^3}{6l} + \frac{M}{2}(x - 2/3l)^2 + Cx + D$$

at point A where $x = 0$, $y = 0$.

$\Rightarrow$ $D = 0$.

at point B where $x = l$, $y = 0$.

$$0 = -\frac{Ml^3}{6l} + \frac{M}{2}(1/3l)^2 + Cl$$

$$0 = \frac{Ml^2}{18} - \frac{Ml^2}{6} + Cl$$

$$C = \frac{Ml}{9}.$$

the equation of slope becomes

$$EI\frac{dy}{dx} = -\frac{Mx^2}{2l} + M(x - 2/3l) + \frac{Ml}{9}$$

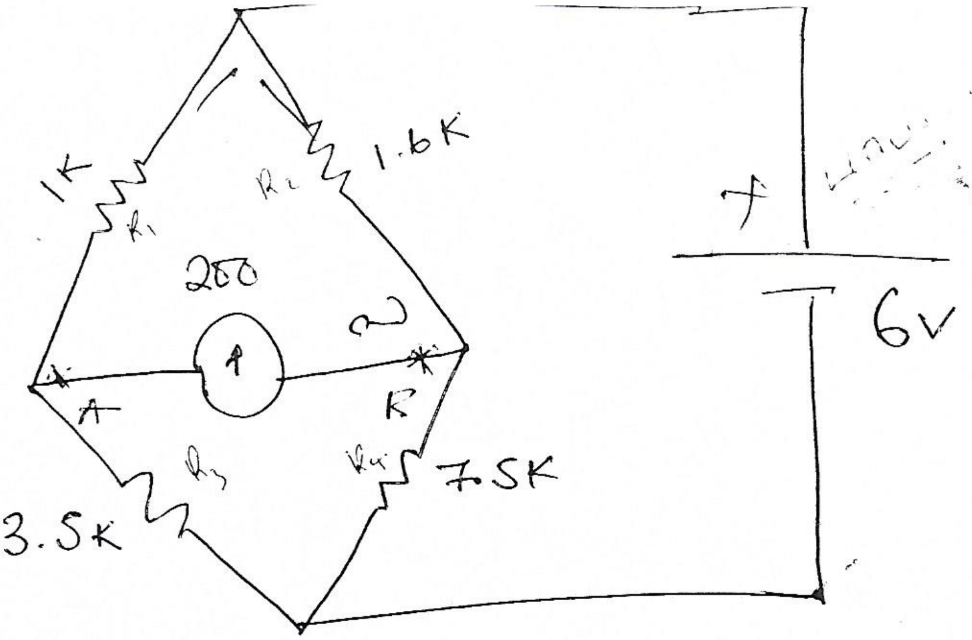
the equation of deflection is

$$EIy = -\frac{Mx^3}{6l} + \frac{M}{2}(x - 2/3l)^2 + \frac{Ml}{9}x.$$

the slope of the beam at the ends

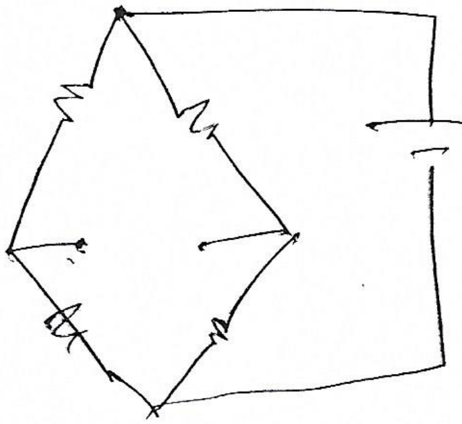
say $x = 0$ and $x = l$.

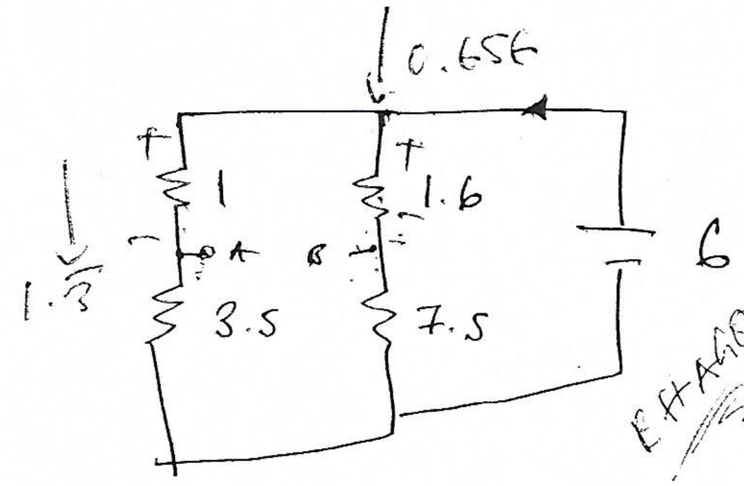
[redacted]



THEVENIN

$V_{TH_{AB}}$





$1.05V - 1.333$

$V_{TH} = 0.283V$

$$I_T = \frac{6V}{R_{eq}} = \frac{6V}{\left(\frac{9.1 \times 4.5}{9.1 + 4.5}\right)} = 1.99mA$$

at $x = 0$

$$EI\frac{dy}{dx} = \frac{ML}{9}$$

$$\left.\frac{dy}{dx}\right|_{x=0} = \frac{ML}{9EI}$$

at $x = L$

$$EI\frac{dy}{dx} = -\frac{ML^2}{2L} + M(\tfrac{1}{3}L) + \frac{ML}{9}$$

$$EI\frac{dy}{dx} = -\frac{ML}{2} + \frac{ML}{3} + \frac{ML}{9}.$$

$$EI\frac{dy}{dx} = -\frac{ML}{18}$$

$$\therefore \quad \left.\frac{dy}{dx}\right|_{x=L} = \frac{-ML}{18EI}$$

for maximum deflection, there must be a point of Slope = 0 within $x < \tfrac{2}{3}L$.

$$\frac{dy}{dx} = 0 \quad \text{for} \quad x_p < \tfrac{2}{3}L.$$

$$0 = -\frac{Mx^2}{2L} + \frac{ML}{9}.$$

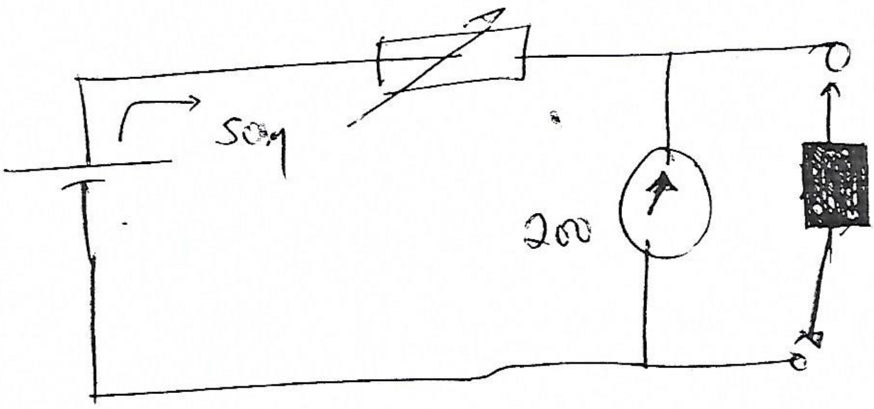
for ifsethe

$$C = \frac{8WC^3}{8ENst^3} \qquad \frac{8WA}{\pi d H} = \frac{G x}{\pi D^3 n} = \frac{\tau}{d}$$

$$R_1 = R_h - \frac{I_{fsd} R_m R_n}{V}$$

$$R_2 = \frac{I_{fsd} R_m R_n}{V - I_{fsd} R_n}$$

~~AAARAM~~



Ammeter

Not exact

I dut Rai

25

$$I_m R_m = I_2 R_z$$

$$R_z = \frac{I_m R_m}{I - I_m} = \frac{0 \; 200}{50\mu - 0} = 0\,\Omega$$

Parallel

$$Z = \frac{0.5 \times 50\mu \times 20}{50\mu - (1/2)(50\mu A)} = 200\,\Omega$$

$$R_z = 1 * 50\times10^{-6} \times$$

$$\frac{Mx^2}{2l} = \frac{Ml}{9}$$

$$x^2 = \frac{2l^2}{9}$$

$$x = \frac{\sqrt{2}\,l}{3}$$

Now, for maximum deflection

$$\boxed{EIy = \frac{-M\left[\frac{\sqrt{2}}{3}l\right]^3}{6l} + \frac{Ml}{9}\,\frac{\sqrt{2}}{3}l.}$$

$$EIy = -\frac{M\,2\sqrt{2}\,l^3}{162l} + \frac{Ml^2\sqrt{2}}{27}$$

$$EIy = \frac{Ml^2\sqrt{2}}{27} - Ml^2\sqrt{2}\,\frac{2}{162}.$$

$$= 2\sqrt{2}\,\frac{Ml^2}{81}$$

$$\therefore\ y = \frac{2\sqrt{2}\,Ml^2}{81EI}$$

$$R_1 = R_n - \frac{I_{fsd} R_m R_n}{V}$$

$$R_2 = \frac{I_{fsd} R_m R_n}{V - I_{fsd} R_n}$$

$R_m = 100\,\Omega$

$I_{fsd} = 1mA$

$V = 3V$

$R_n = 2000\,\Omega$

$$R_1 = 2000 - \frac{(1\times10^{-3})(100)(2000)}{3}$$

$R_1 = 1933.3\,\Omega$

$$R_2 = \frac{(1\times10^{-3})(100)(2000)}{3 - (1\times10^{-3})(2000)}$$

$= 200\,\Omega$

(2) 5% drop $= 5\% \times 3 = 0.15V$

drop $= 3 - 0.15 = 2.85$

$$R_2 = \frac{I_{fsd} R_m R_n}{V - I_{fsd} R_n} = \frac{(1\times10^{-3})(100)(2000)}{2.85 - (1\times10^{-3})(2000)}$$

$= 235.29\,\Omega$

Question 2

Same length, same torque for a same shear stress because they have same material.

Let D_H = Outer diameter of hollow

d_H = Inner diameter of hollow

D_s = diameter of solid

W_H = Weight of hollow

W_s = Weight of solid

comparison ration $\frac{W_H}{W_s} = \frac{\text{Weight of hollow}}{\text{Weight of Solid}}$

weight $W = mg = \rho V = \rho A L$, for the materials with same length and same density

$$\frac{W_H}{W_s} = \frac{A_H}{A_s} = \frac{\frac{\pi}{4} D_H^2 - \frac{\pi}{4} d_H^2}{\pi/4 \; D_s^2}$$

$$\frac{W_H}{W_s} = \frac{A_H}{A_s} = \frac{D_H^2 - d_H^2}{D_s^2}$$

for the special case

$$d_H = 3/4 \; D_H$$

$$R_1 = \frac{R_h - I_{fsd} R_m R_h}{V}$$

$$R_2 = \frac{I_{fsd} R_m R_h}{V - I_{fsd} R_h}$$

$$R_1 = R_h - \frac{I_{fsd} R_m R_h}{V}$$

$$R_2 = \frac{I_{fsd} R_h R_m}{V - I_{fsd} R_h}$$

spielbergs

Analog meter

D' Arsonvel meter

SHORT comming!

$$\frac{W_H}{W_S} = \frac{D_H^2 - \left[\frac{3}{4} D_H\right]^2}{D_S^2} = \frac{D_H^2\left[1 - \left(\frac{3}{4}\right)^2\right]}{D_S^2}$$

$$= \frac{D_H^2(0.4375)}{D_S^2} \text{ - - - - } *$$

from the Torsion equation

$$\frac{\tau}{R} = \frac{G\theta}{L} = \frac{T}{J}$$

to transmitt a given torque for same shear force.

$$\frac{J}{R} = \frac{T}{\tau} = \text{Constant}$$

$$\frac{J_H}{R_H} = \frac{J_S}{R_S}$$

$$\frac{\frac{\pi}{32} D_H^4 - \left[\frac{3}{4} D_H\right]^4}{D_H/2} = \frac{\frac{\pi}{32} D_S^4}{D_S/2}$$

$$D_H^3\left(\frac{175}{256}\right) = D_S^3$$

$$D_S = 0.8809\ D_H$$

replacing in $*$ for D_S

$$(R_C + R_D) = \frac{(6080 + R_A + R_B)(50\times10^{-6})}{(10\times10^{-3} - 50\times10^{-6})}$$

$$(R_C + R_D) = (62526.3 + R_B)\ 5.025125\times10^{-3}$$

$$(R_C + R_D) = 314.2025 + R_B(5.025125\times10^{-3})$$

$$R_B + R_B(5.025125\times10^{-3}) = -314.2025 + (606.060 + 2526.3$$

$$0.0101)$$

$$R_B = \boxed{315.786\,\Omega}$$

$$R_D = \frac{(60000 + R_A + R_B + R_C)(50\times10^{-6})}{(20\times10^{-3} - 50\times10^{-6})}$$

$$R_D = [(62842.08626) + R_C]\ 2.50626\times10^{-3}$$

$$R_D = 157.4989 + R_C(2.50626\times10^{-3})$$

$$R_C + R_C[2.50626\times10^{-3}) = 314.2025 + 1.586 - 157$$

$$\boxed{R_C = 157.89\,\Omega}$$

$$R_D = \boxed{157.8942\,\Omega}$$

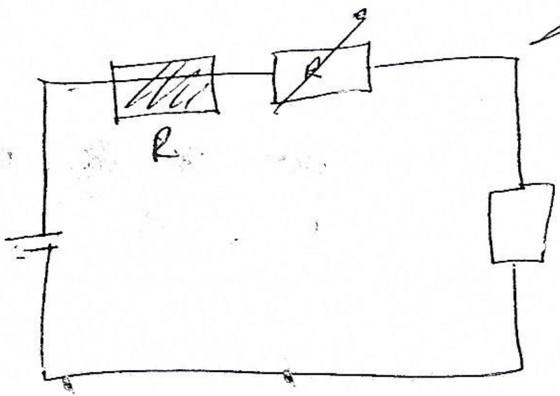
$$\frac{W_H}{W_S} = \frac{\Delta \cancel{H}^2 (0.4375)}{\Delta \cancel{H}^2 \cdot (0.8809)^2}$$

$$\frac{W_H}{W_S} \cong \underline{\underline{0.563}}$$

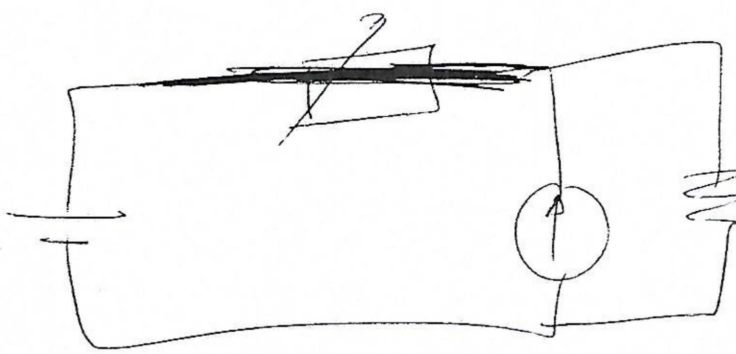
$\frac{1.5}{2m} = 7.8\times10^{-?}$

$V = 0.75\ 2m\ F\ 0.75\ R$

That what they say



1/40 90

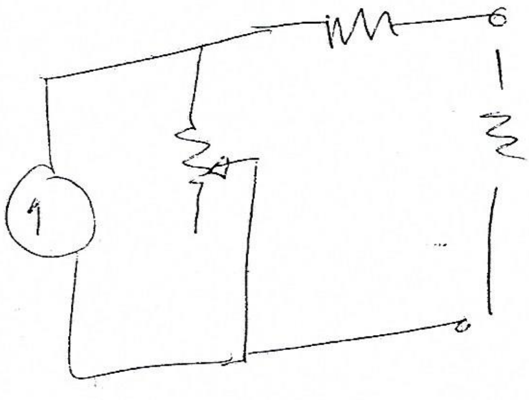


No

~~$R_2 I_m = 0$~~

~~Nothing~~ Zero

So equal?

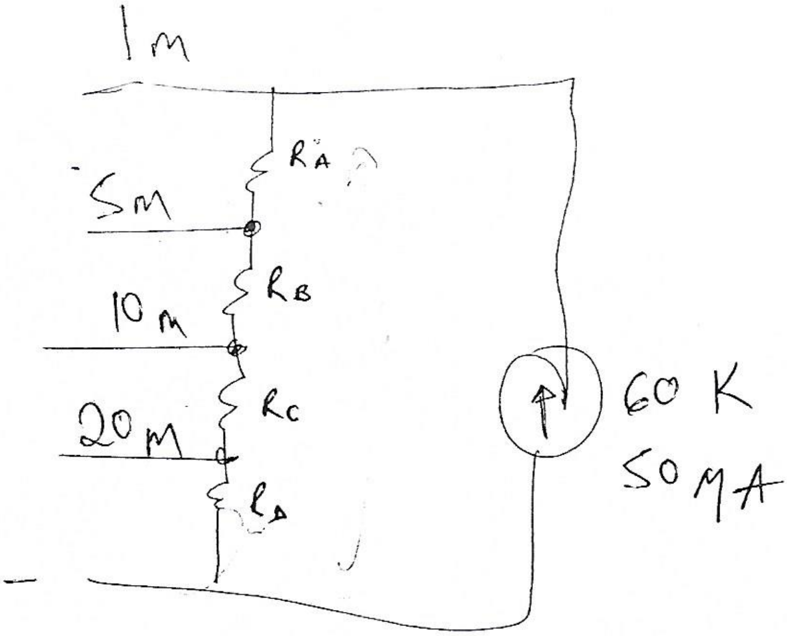


Source

current is $\frac{1.5}{2m} = 7.5\times10^{-4}\ A$

$R_m I_m + R_2 I_m = V$

$1.5 + R_2 I_m = 1.5$



$$R_{SH} I_{SH} = R_m I_m$$

$$R_{SH} = \frac{R_m I_m}{I_{SH}} \qquad R_{SH} = \frac{R_m I_m}{I - I_m}$$

① $$(R_A + R_B + R_C + R_D) = \frac{60{,}000 \times 50 \times 10^{-6}}{1 \times 10^{-3} - 50 \times 10^{-6}}$$

$$(R_A + R_B + R_C + R_D) = 3157.89 \quad ①$$

② $$(R_B + R_C + R_D) = \frac{(60000 + R_A) \times 50 \times 10^{-6}}{(5 \times 10^{-3} - 50 \times 10^{-6})}$$

$$(R_B + R_C + R_D) = 606.0606 + R_A(0.0101)$$

$$R_A + R_A(0.0101) = 3157.89 - 606.06$$

$$\underline{R_A = 2526.3\,\Omega}$$