THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

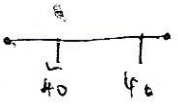
TERM 3 – JULY 2016
EEE 3112 - ELECTRICAL ENGINEERING PRACTICE

ANSWER ALL QUESTIONS — TIME ALLOWED 2 HOURS
CLOSED BOOK

Question 1

A 4m long beam supported by pin joints at its ends, carries two 40kg motors at ¼ and 3/4 of the span of the beam. All motors rotating in the same direction, deliver 60kw at 3000rpm to downstream applications. Find:

(a) The reactions at the pin joints (6 marks)
(b) expressions for the slope of the beam at each end in terms of EI. (10 marks)
(b) expression for the maximum deflection in terms of EI. (9 marks)



Question 2

You have been commissioned to design the suspension for a new light truck. The net weight of the light truck up is 3200kg, distributed 35% on the rear axle and 65% on the front axle. When fully loaded an additional 7000kg is added to the light truck, distributed 80% on the rear axle and 20% 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	=	30cm
Modulus of rigidity	=	83.5 GN/m^2
Wire diameter	=	35mm

Leaf spring:

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

Find:

(a) the number of complete coils required in the helical springs (6 marks)
(b) the width of the leaf springs (6 marks)
(c) the deflection at both axles when acted upon the net weight of the pickup only. (6 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 gravity of the pickup when loaded with the additional 5000kg. (7 marks)

Question 3

A solid 1m shaft of radius 60 mm and density 4 g/cm^3 carries 4 unbalanced masses spaced as follows:

Masses A, B, C, and D are 13, 12, 11, and 10kg respectively, rotating at radii 10, 11, 12, 13cm respectively, and spaced from one end of the shaft at 30, 45, 60, and 75 cm respectively. the angular spacing from A to B, C, and D are 60, 120, and 180° respectively.

(a) Balance the shaft using two 15 kg masses at either end (9 marks)

(b) If before balancing, the shaft rotated at 3000 rpm what will be its rotation after balancing. (7 marks)

(c) If all masses are removed from the shaft and the power transmitted is 150 kW, determine the maximum shear stress on the shaft. (9 marks)

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

Question 4

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 (6 marks)

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

(b) the stiffness of the suspension (5 marks)

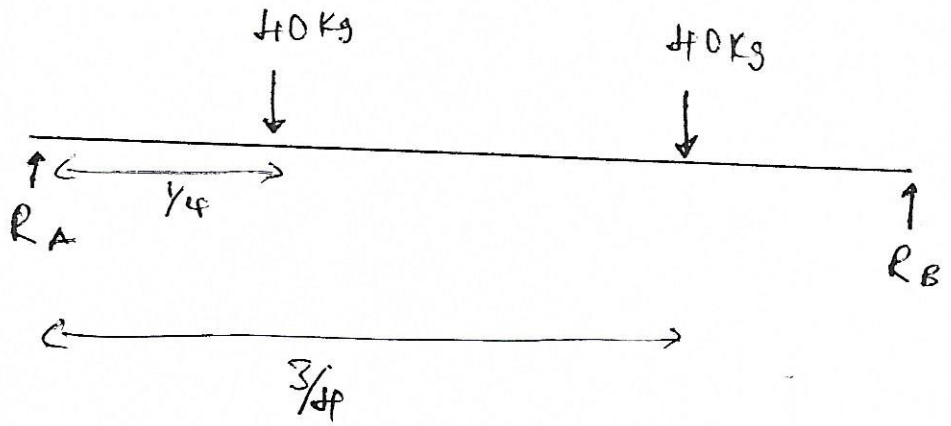
(c) the speed in km/h of the vehicle at maximum displacement (7 marks)

(d) the maximum displacement of the vehicle if the and the vehicle is moving a 140km/h (7 marks)

END OF TEST

$$\frac{x}{y} = \sqrt{\frac{1+(2\xi r)^2}{(1-r^2)^2+(2\xi r)^2}}$$

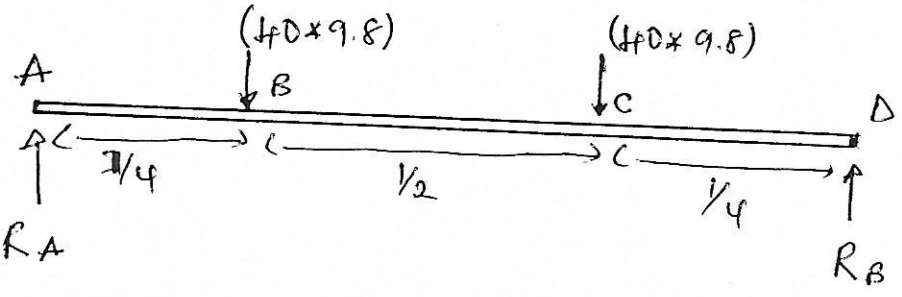
Question 1



Regina T. Nyirenda

Question does not specify if motors are directly linked or coupled to beam or just sitting on top as weights, So assuming the two motors are simply weights

(a) for length of beam = L

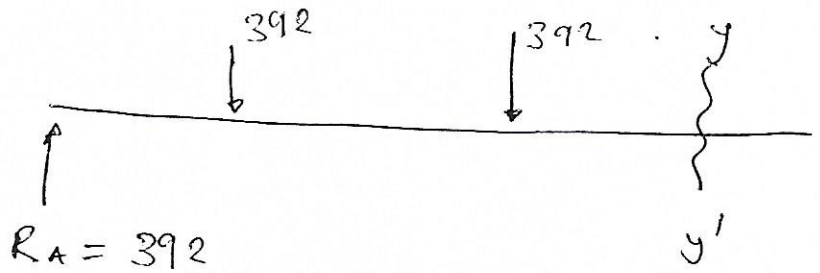


$\sum M_A$ gives $R_B = 40Kg$

$\therefore R_A = 40Kg$

(b)

Choosing a section of length x at y y'



$$M = 392x - 392(x - 1/4l) - 392(x - 3/4l)$$

$$EI\frac{d^2y}{d^2x} = M$$

$$EI\frac{d^2y}{d^2x} = 392x - 392(x - 1/4l) - 392(x - 3/4l).$$

$$EI\frac{dy}{dx} = \frac{392x^2}{2} - \frac{392}{2}(x - 1/4l)^2 - \frac{392}{2}(x - 3/4l)^2 + C$$

$$EIy = \frac{392}{6}x^3 - \frac{392}{6}(x - 1/4l)^3 - \frac{392}{6}(x - 3/4l)^3 + Cx + D$$

at ends, $y = 0$ Say at $x = l$ and $x = 0$ ...

at $x = 0$ $\quad x = l$

$0 = D$ $\quad 0 = \frac{392l^3}{6} - \frac{392}{6}(l - 1/4l)^3$

$$- \frac{392}{6}(l - 3/4l)^3 + Cl$$

$$-Cl = \frac{392}{6}l^3 - \frac{392}{6}l^3\left(\frac{27}{64}\right) - \frac{392}{6}l^3\left(\frac{1}{64}\right)$$

$$-C = \frac{392}{6}l^2 - 27.5625l^2 - 1.020l^2$$

$$C = -36.75l^2$$

Expression for slope of beam

$$EI\frac{dy}{dx} = \frac{392x^2}{2} - \frac{392}{2}\left(x-\tfrac{1}{4}l\right)^2 - \frac{392}{2}\left(x-\tfrac{3}{4}l\right)^2 - 36.75l^2$$

end 1 where $x=0$

$$EI\frac{dy}{dx} = -36.75l^2$$

$$\frac{dy}{dx} = \frac{-36.75l^2}{EI}$$

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for end 2 where $x=l$

$$EI\frac{dy}{dx} = \frac{392l^2}{2} - \frac{392}{2}\left(l-\tfrac{1}{4}l\right)^2 - \frac{392}{2}\left(l-\tfrac{3}{4}l\right)^2 - 36.75l^2$$

$$EI\frac{dy}{dx} = 196l^2 - \frac{441}{4}l^2 - \frac{49}{4}l^2 - 36.75l^2$$

$$EI\frac{dy}{dx} = 32.75l^2$$

$$\therefore \frac{dy}{dx} = \frac{32.75\,L^2}{EI}$$

(c) Expression for Maximum Slope.

the max deflection is between $\frac{1}{4}L$ and $\frac{3}{4}L$

for $\frac{dy}{dx} = 0$

$$\frac{392}{2}x^2 - \frac{392}{2}\left(x - \frac{1}{4}L\right)^2 - 36.75L^2 = 0$$

$$\frac{392}{2}x^2 - \frac{392}{2}\left(x^2 - \frac{1}{2}xL + \frac{L^2}{16}\right) - 36.75L^2 = 0$$

$$\frac{392}{2}\left[+\frac{1}{2}xL - \frac{L^2}{16}\right] - 36.75L^2 = 0$$

$$98xL - \frac{196L^2}{16} - 36.75L^2 = 0$$

$$x = 0.5L$$

Max deflection

$$y = \frac{392}{6}(0.5L)^3 - \frac{392}{6}(0.5L - \frac{1}{4}L)^3 - 36.75L^2$$

$$EI$$

$$y = \frac{5.1667x^3 - 1.02x^3 - 36.75x^2}{EI}$$

Question 2

Net weight = 3200 Kg δ = 15cm

35% on rear axle

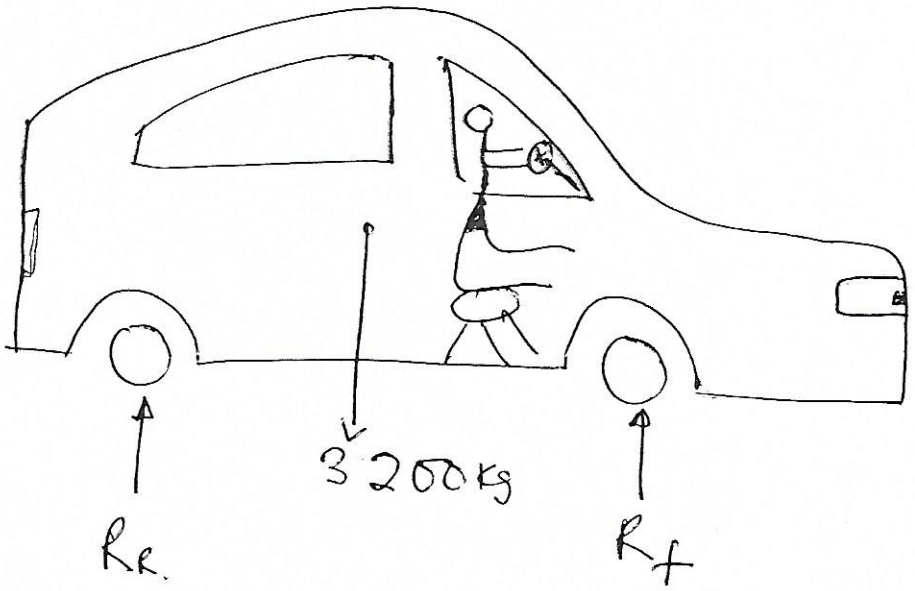
65% on front axle

Loading = 7000 Kg

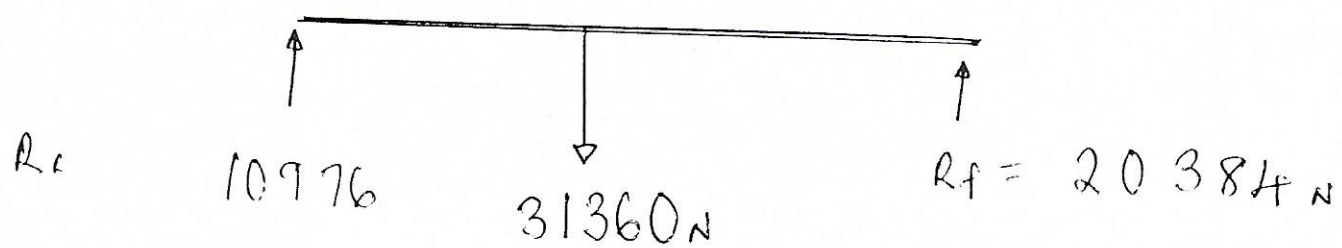
80% on rear axle

20% on front axle

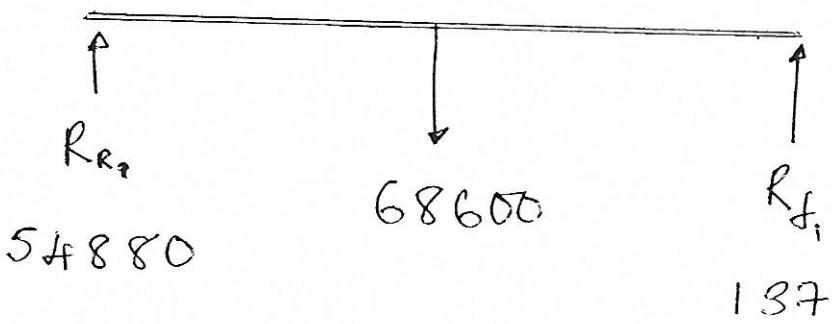
(a) diagram



free body diagram



for the loads



Total force on Rear axle = 54880 + 10976

= 65856 N

Total force on from axle = 13720 + 20384

= 34104 N

(a) Number of complete coils in helical springs.

Since Springs are in parallel

$$\text{Load/Spring} = \frac{\text{load}}{2} = 17052\ N$$

$$\delta = \frac{64\ W R^3 n}{G d^4}$$

$$\delta G d^4 = 64\, W R^3 n$$

$$n = \frac{\delta G d^4}{64\, W R^3} = \frac{(0.15)\,(83.5\times10^9)(0.035)^4}{64 * 17052 * (0.15)^3}$$

$$n = \frac{18.795\times10^3}{3683.232}$$

$$n = 5.1028$$

number of Complete Springs, if we choose. 5 the 0.1028 will Cause extra deflection

∴ Complete coils better be 5 in design

$$\underline{n = 5}$$

(b) $$\delta = \frac{3WL^3}{8ENbt^3}$$

Load per spring $= \frac{6585.6}{2} = 3292.8$

$L = 1m$

$N = 8$

$E = 125 \times 10^9$

$\frac{b}{t} = \frac{8}{1}$

$b = 8t$

$t = \left(\frac{b}{8}\right)$

$$0.15 = \frac{(3)(3292.8)(1)^3}{(8)(125\times10^9)(8)(b)\left(\frac{b}{8}\right)^3}$$

$$\frac{1.2\times10^{12} b^4}{512} = 98784$$

$b^4 = 4.214 \times 10^{-5}$

$b = 0.08057m$

$b = 8.057cm$

(c) Deflection when acted upon by net weight only.

front axle.

$$\delta = \frac{64WR^3n}{Gd^4} = \frac{64 * 1019.2 * (0.15)^3 * 5}{(83.5\times10^9) \times (0.035)^4}$$

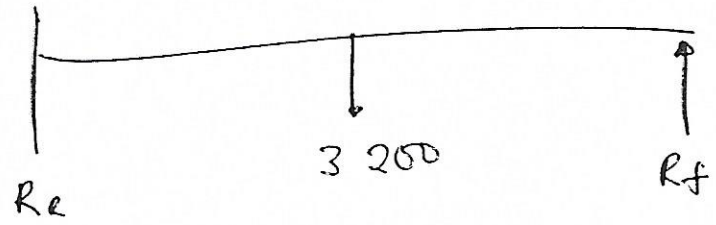
$\delta = 8.784cm$

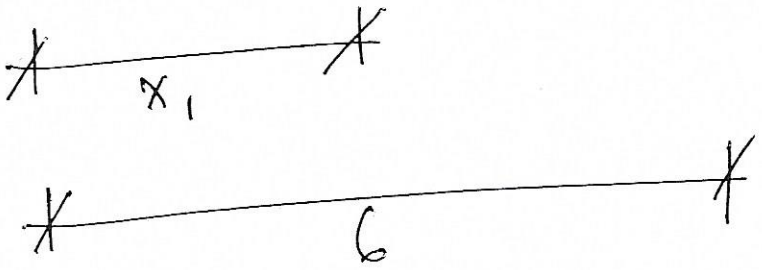
deflection on Rear axle.

$$\delta = \frac{3WL^3}{8ENbt^3} = \frac{3 * 5488 * 1^3}{8 * 125 \times 10^9 * 8 * 0.08057 * (0.01)^3}$$

$$\delta = 2.500\text{cm}$$

(d) Centre of gravity Shift



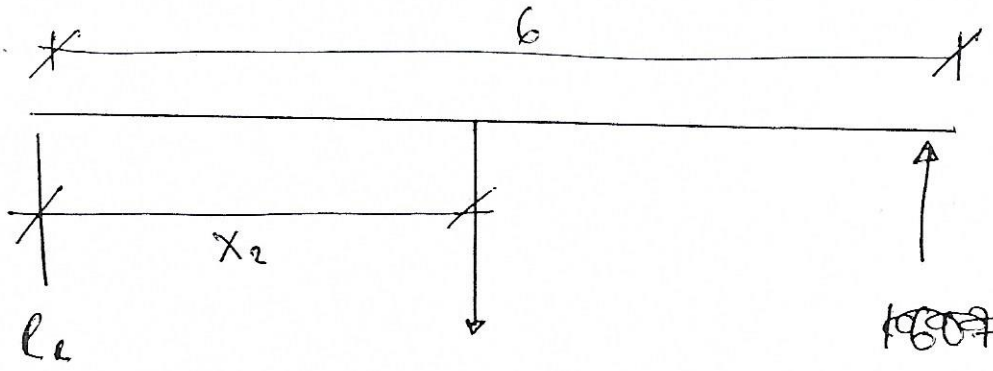


$$\sum M_{RR} = 0$$

$$(31360 \times x_1) = (20348 * 6)$$

$$X_1 = 3.9\text{cm}$$

After 5000 loading



provided that after loading the share of weights is as given in question on 7000 kg

Say 80% rear

20% front

$$\sum M R_2 = 0$$

$$80360 x_2 = 1607.2 \times 6 \times 10$$

$$x_2 = 0.12\text{cm} \times 10$$

$$x_2 = 1.2\text{cm}$$

from the two calculations

the centre of gravity shifts towards the rear axle by $(3.9 - 1.2) = 2.7\text{cm}$

$$3.9 - 1.2 = \underline{\underline{2.7\text{cm}}}$$

Question 3

(a)

Ref	Mass	Θ	r	L	mr	mrl	mrl cosΘ	mrl sinΘ
A	13	0	0.1	0.3	1.3	0.39	0.39	0
B	12	60	0.11	0.45	1.32	0.594	0.297	0.514
C	11	120	0.12	0.6	1.32	0.792	-0.396	0.686
D	10	180	0.13	0.75	1.3	0.975	-0.975	0
x	15			0				
y	15			1				
Σ							-0.684	1.2

$\Sigma Mrl\cos\theta = -0.684$

$\Sigma Mrl\sin\theta = 1.2.$

$$Mrl = \left[(1.2)^2 + (0.684)^2\right]^{1/2} = 1.381$$

for y

$L = 1$

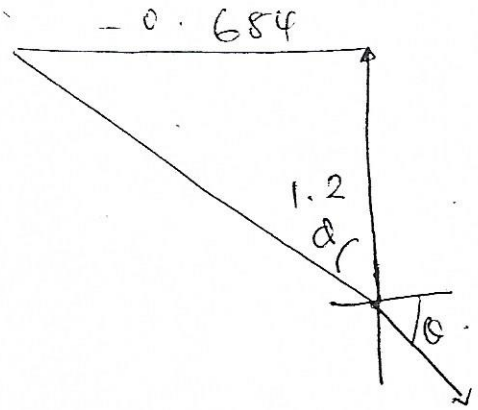
$m = 15$

$$r = \frac{1.381}{15} = \underline{9.208\,cm}$$

$$\theta = \tan^{-1}\left(\frac{1.2}{-0.684}\right)$$

$$= -60.316^\circ$$

(a)



$\therefore \theta = 300°$

Solving for mass X using mr

Q	Mass	mr	mr cos Q	mr sin Q
0	A	1.3	1.3	0
60	B	1.32	0.66	1.143
120	C	1.32	-0.66	1.143
180	D	1.3	-1.3	0
300	y	1.3812	0.6906	-1.196
	X			

$\sum mr \cos Q = 0.6906$

$\sum Mr \sin Q = 1.09$

$Mr = \left[(1.09)^2 + (0.6906)^2\right]^{1/2}$

$Mr = 1.29$

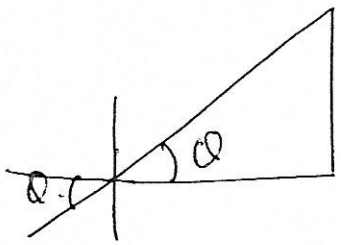
for X

$M = 15$

$\therefore r = \frac{1.29}{15} = 8.60 \text{ cm}$

$$\theta = \tan^{-1}\left(\frac{1.09}{0.6906}\right)$$

$$\theta = 57.64^\circ$$



$$\therefore \theta = 180 + 57.64$$

$$= \underline{237.64^\circ}$$

∴ Balancing of Masses is

X = 15Kg, radius = 8.60cm, ℓ = 0m

$\theta = 237.64^\circ$

Y = Mass = 15 Kg, radius = 9.208cm, ℓ = 1m

$\underline{\theta = 300^\circ}$

Initial rotation = 3000 rpm

using Conservation of Momentum

$$L_i = L_f$$

$$L_i = \left(I_s + \sum I_m\right) w$$

$$I_s = \frac{mr^2}{2} = \frac{m \times \left(\frac{60}{1000}\right)^2}{2}$$

calculations for m

$$\rho = 4\ g/cm^3$$

$$V = \pi r^2 L = 6^2 \cdot \pi \cdot 4 \times 100$$

$$m = \rho V = 45.24\ Kg$$

$$I_s = \frac{(45.24)\left(\frac{60}{1000}\right)^2}{2} = 0.081432\ Kg\,m^2$$

$$\sum I_m = \sum m_i r^2 = (13)(0.1)^2 + 12(0.11)^2 + 11(0.12)^2 + 10 \times (0.13)^2$$

$$= 0.6026\ Kg\,m^2$$

$$L_i = (0.6026 + 0.081432)\ 3000$$

$$L_f = \omega_f (0.081432 + \Sigma I_m)$$

$$= \omega_f (0.081432 + 0.6026 + 0.2351)$$

$$L_i = L_f$$

$$\omega_f = \frac{2052.096}{0.922\,1528}$$

$$\underline{\omega_f = 2225.33 \text{ rpm}}$$

(c) again Conserving momentum.

$$(2225.33)(0.922132) = 0.081432(\omega_f)$$

$$\underline{\omega_f = 25.19952 \times 10^3 \text{ rpm}}$$

$$P = \frac{2\pi N T}{60}$$

$$T 2\pi N = P.60$$

$$T = \frac{P.60}{2\pi N} = \frac{(150\,000)(60)}{2 * \pi * 25.19952 \times 10^{3}}$$

$$\underline{T = 56.842\ Nm}$$

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

$$\tau = \frac{TR}{J} = \frac{(56.842)(0.06)}{\frac{\pi}{32}(0.12)^4}$$

$$\boxed{J = \frac{\pi}{32} D^4}$$

$$\tau = \frac{3.41052}{2.035 \times 10^{-5}} = \underline{\underline{167.531\ KN/m^2}}$$

Question 4

mass $m = 1850\ kg$

$y = 36cm$

$x = 42cm$

(a) Since data given is at maximum, this implies that $\omega = \omega_n$

$$\therefore \frac{\omega}{\omega_n} = 1$$

using transmissibility ratio T_d.

$$T_d = \frac{x}{y} = \left[\frac{1 + (2\zeta r)^2}{(1-r^2)^2 + (2\zeta r)^2}\right]^{1/2}$$

where ζ = damping ratio

$$\left(\frac{42}{36}\right)^2 = \frac{1 + 4\zeta^2}{(1-1) + 4\zeta^2} \qquad r = 1$$

$$\left(\frac{42}{36}\right)^2 = \frac{1}{4\zeta^2} + 1$$

$$0.3611 = \frac{1}{4\zeta^2}$$

$$\frac{13}{9}\zeta^2 = 1$$

$$\Rightarrow \zeta = 0.832$$

$\therefore$ it is underdamped

Length of one modulation is 2m

$C = 9500\ Kg/s$

(b) Stiffness.

$$\omega_n = \sqrt{\frac{K}{m}}$$

$$K = (\omega_n)^2 m$$

using $\zeta = \frac{C}{m 2\omega_n}$

$$2\zeta\omega_n m = C$$

$$\omega_n = \frac{C}{m 2\zeta} = \frac{9500}{(18.50)(2)(0.832}$$

$$\omega_n = 3.0858\ rads/s$$

$$K = (\omega_n)^2 . m = (3.0858)^2 . 18.50$$

$$\underline{\underline{K = 17616.37\ N/m}}$$

(c) the speed in km/h at max displacement.

$\omega_n = 3.086 \text{ rad/s}$

$\omega = 2\pi f$

$f = \frac{\omega_n}{2\pi} = \frac{3.086}{2\pi} = 0.4911 \text{ Hz}.$

Speed $= 2 * 0.4911$

$= 0.9823 \text{ m/s}$

$= \underline{3.536 \text{ km/h}}$

(d) Displacement given speed $= 140 \text{ km/h}$

140 km/h

$= 38.889 \text{ m/s}$

using ratios

$x — 38.89$

$42 — 3.536$

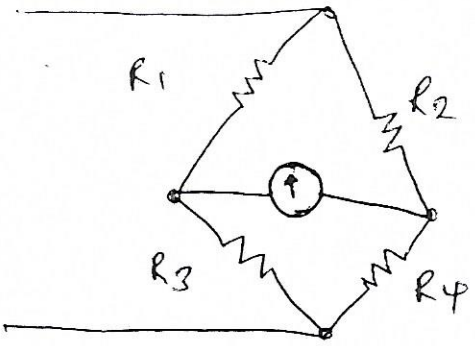
they are directly proportional

$x = \frac{42 \times 3.536}{38.89}$

$x = 3.8188 \text{ cm}$

digital.

Jasper's Signals



at balance.

$I_1 = I_3 \quad I_2 = I_4$

$$\frac{I_1 R_1 = I_2 R_2}{I_1 R_3 = I_2 R_4}$$

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

$R_4 R_1 = R_3 R_2$

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

$$R_x = \frac{4.5 \times 10}{15} = \frac{45}{15} = 3$$

$\log_2 8 = 3$

$\log_2 8 = x$

$= 2^x = 8$

$\log_2 8 = x$

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS

FINAL EXAM – July/August 2014

EEE3112

EEE 3112: ELECTRICAL ENGINEERING PRACTICE

Regina T. Nyirenda

TIME	:	Three (3) hours
INSTRUCTIONS	:	Answer any five questions: One Question from Section A, Two (2) from Section B and Two (2) from section C
ADDITIONAL	:	*No Materials Allowed in Examination*

SECTION A: ANSWER ATLEST ONE (1) QUESTIONS FROM THIS SECTION

QUESTION 1

For the beam loaded as shown in **Figure Q1**.

a) Determine the deflection at the position midway between the supports and at the overhanging end. **[16Marks]**

b) Find the slope at the overhanging end **[4Marks]**

Flexural rigidity EI = 280,000Nm^2

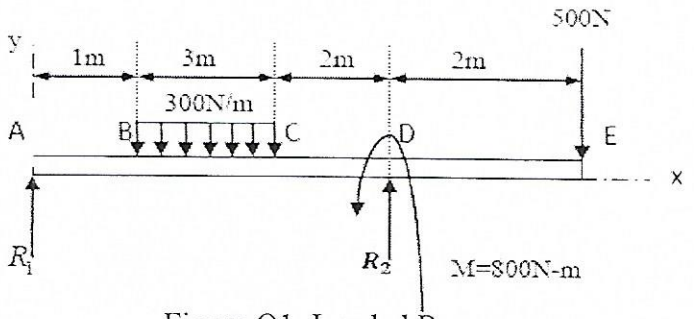


Figure Q1: Loaded Beam

Total [20 Marks]

QUESTION 2

a) During the design of the spring-support system, **Figure Q2** , for the 4000kg weighing platform at Kafue Weigh Bridge, it was decided that the frequency of free vertical vibration in the loaded condition with a 40Mg truck shall not exceed 1 cycle per second.

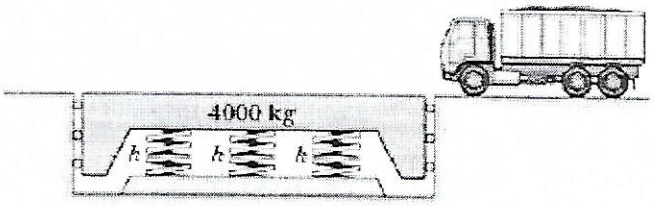


Figure Q2: Spring Support System

i. Determine the maximum acceptable spring constant k for each of the three identical springs. **[4Marks]**

ii. For this spring constant, what would be the natural frequency f_n of vertical vibration of the unloaded platform? **[4Marks]**

iii. Hence write the differential equation of motion of vibration for the unloaded platform **[4Marks]**

iv. Evaluate the static deflection δ_{st} of each spring for the loaded platform.

b) Name any two types of springs. **[4Marks]**

Total [20Marks]

→ linear spring

→ rotational spring

SECTION B: ANSWER ANY TWO (2) QUESTIONS FROM THIS SECTION

QUESTION 1

Design and draw the circuit diagram of LED based reading lamp that can be supplied from the main 240VAC, 50Hz supply system and solar panel. The circuit should consist of the following components.

- Transformer, 240/12V
- Converter (AC/DC)
- Smoothing Capacitor,
- IC 7805 Regulator, 5V, 1A
- 10 White LEDs, each rated 2.7V, 30mA

NOTE: Neglect the power losses in the transformer and the converter.

a) Design and briefly explain the function of each major component of the LED reading lamp. **[10Marks]**

b) Calculate

i. The limiting resistors for the LEDs. **[1Mark]**

ii. The smoothing capacitor C1 for 10% ripple **[2Mark]**

iii. The power rating of the LED Based Reading Lamp. **[5Marks]**

iv. The amount of energy the LED based reading lamp consume in a month if it operates for 150hours per month. **[2Marks]**

Total [20Marks]

QUESTION 2

a) Figure Q2 shows a circuit diagram of a solar lamp used to charge the battery during the day and light the LEDs at night. The solar panel is rated 12V, 10W, each white LED light 1 & 2 in the circuit is rated 2.5V, 1W and the Red LED is rated 2V, 20mA. The relay is rated 6V d.c, 100Ω. Diodes 1 to 3 are made of silicon and Battery is rated 6V, 4.5Ah.

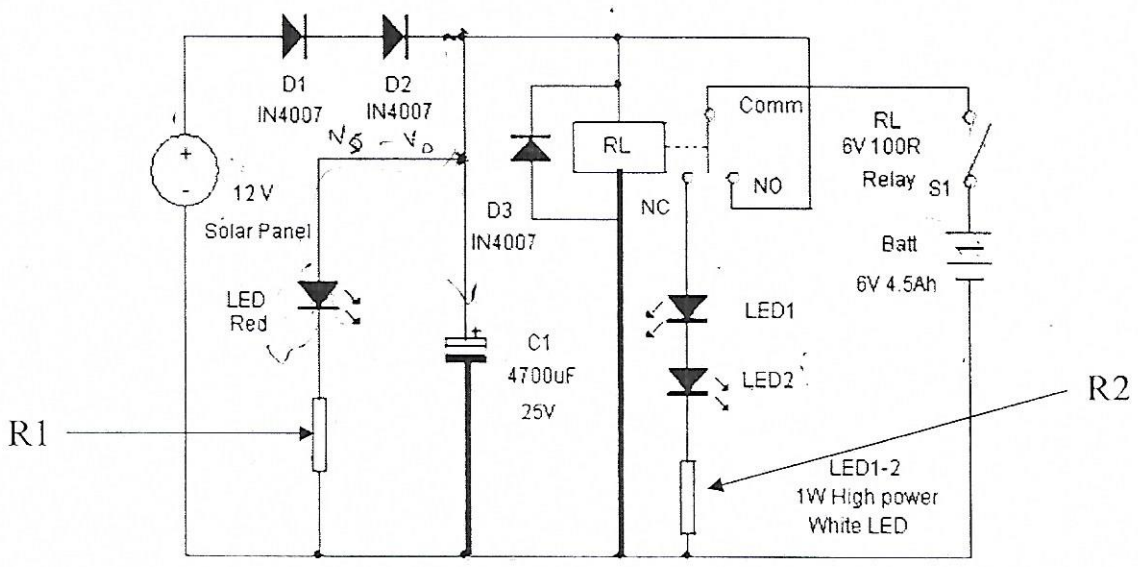


Figure Q2: Solar Lamp Circuit Diagram

Calculate

i. The number of hours that the battery can supply the two LEDs before it completely discharges. **[3Marks]**

ii. The value of limiting resistances R2 and R1. **[2Marks]**

iii. The number of hours needed to charge the battery if the battery is initially completely discharged. Assuming the panel is supplying constant power for 8 hours of sunshine. **[7Marks]**

iv. State one advantage and one disadvantages of connecting LED lights in series in line with the battery life and brightness of LED. **[2Marks]**

b) In the context of electrical and electronics diagram:

i. State any three uses of the circuit diagram. **[3Marks]**

ii. State the three main types of diagrams used in electrical and electronics to represent electrical systems or equipments. **[3 Marks]**

Total [20 Marks]

QUESTION 3

a) An engineer has two small resistors and two capacitors that they would like to use in they circuit diagram. The following are the colours of these components:

- Resistor 1: Red, Violet, Gold and Silver
- Resistor 2: Blue, Grey, Silver and Silver
- Capacitor 1: Black, Brown, and Orange
- Capacitor 2: Blue, Orange, Green and White Spot

i. State the values of each resistors and capacitors. **[5Marks]**

ii. State any three applications of capacitor. **[3Marks]**

b) Design the circuit diagram of liquid level detector alarm/switch based automatic emergency pumping system. The device is to be used for alerting when the liquid level in the tank has gone down below ¼ of the tank and automatically switches on the pump to start filling up the tank. The floater is used as the sensor to switch on the system when water level reduces to ¼ of the tank. The circuit should consists of the following components:

- ❑ Regulated Power Supply, 240/12V, 3A
- ❑ Pumping System (Motor), 240V, 50Hz, 1hp
- ❑ Indicators for full/Quarter tank,
- ❑ Sound System (Buzzer), 12V, 1A
- ❑ Relay (RL) 12V, 100Ω

i. Design and draw the circuit diagram of the liquid level detector alarm/switch system. **[7Marks]**

ii. Describe briefly how the circuit diagram you have designed operate. **[5Marks]**

Total [20Marks]

SECTION C: ANSWER ALL TWO (2) QUESTIONS FROM THIS SECTION

QUESTION 1.

a) A voltmeter is accurate to 98% of its full scale deflection reading.

i. What is the error of the reading of full scale deflection? **[1/2Marks]**

ii. If the voltmeter reads (x – t) volts on 10 volts range, what is the absolute error? **[1/2Marks]**

iii. If x = 2 and t = 1 what is the error, expressed as percentage, of the reading in (b)? **[1/2Marks]**

iv. With regards to your answer in (c) what can be concluded regarding voltmeter readings at different ranges. **[1/2Marks]**

v. Briefly describe three types of systematic errors. **[3 Marks]**

b) Briefly describe the following terms:

i. A standard, **[1Mark]**

ii. Calibration, **[1Mark]**

iii. Performance specification. **[1Mark]**

c) A researcher took the following measurements from the routine testing of his 5 volts regulated power supply. The readings are tabulated in the table below:

4.877	4.9976	4.998	5.09	5.003	5.2

Find the most precise reading so that all figures in columns to the right of the last column in which all figures are significant should be dropped. **[8Marks]**

d) An 620Ω resistance with an accuracy of 10% carries a current of 10 mA. The current was measured by an analog ammeter on a 20mA range with an accuracy of full scale. Calculate the power dissipated in the resistor, and determine the accuracy of the result. **[4Marks]**

Regina - T. Nyirenda **Total [20Marks]**

QUESTION 2.

a) Briefly explain loading effect and insertion loss of the measuring instrument. **[2Marks]**

b) Briefly describe statutory testing, citing examples where it is mostly applied. **[2Marks]**

c) A factory has 200 machines and the maintenance engineer supervises the repair crews who repair malfunctioning machines. The maintenance policy is to repair the broken down machine and bring back in production within 2 hours on the average. If average

breakdown rate is 3.5 machines/hour and each repair crew can repair 0.25 machine per hour on the average. How many repair crews are required ? **[6 Marks]**

d) Convert a basic D' Arsonval moving coil meter with an internal resistance of 120Ω and a full scale deflection current of 2 mA into a multirange dc voltmeter with voltage ranges of 0-10V, 0-50V, 0-100V and 0-250V. You may use the circuit given in figure Q2 below. **[10Marks]**

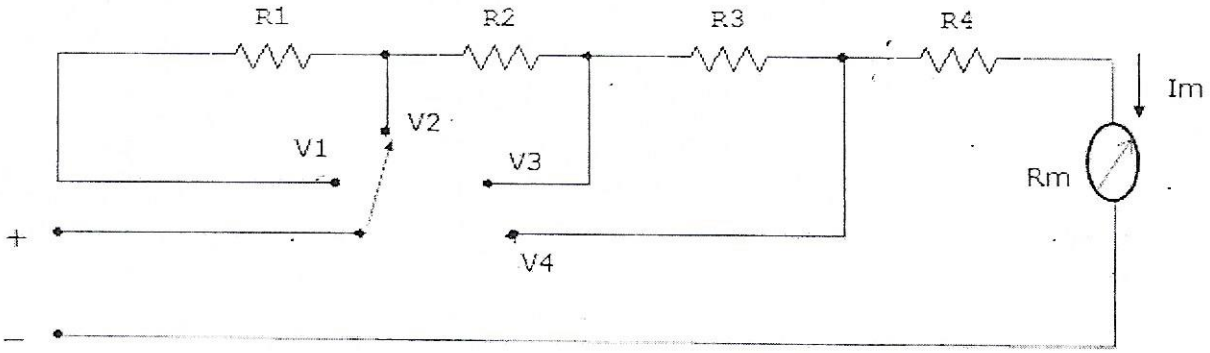


Figure Q2. Multirange Voltmeter.

Total [20Marrks]

END OF EEE3112 EXAMINATION