



INTERNAL ASSESSMENT APPROVAL FORM (INCLUDING COLLABORATIVE PROVISION)

This form is used to ensure that assessment specifications have been through an internal review process prior to external examination/approval and release to students. It should be completed for each assessment for a particular module. The assessment tasks, criteria and marking scheme should accompany this form.

PARTNER (and taught location if relevant):	Coleg Sirgar				
EXTERNAL EXAMINER NAME:	TO BE ADVISED				
ASSESSMENT AUTHOR:	CHWY DAVIES				
MODULE TITLE:	MECHANICAL SCIENCE 1				
MODULE CODE:	SEM4002		MODULE LEVEL:	4	
COMPONENT NO. (e.g. 1 of 2):	2 (MAINT REIT EXAMS)		COMPONENT WEIGHTING (e.g. 50% of the module):	50%	
ASSESSMENT PERIOD	☐ Semester 1	☐ Semester 1 Re-sit	☒ Semester 2	☐ Semester 2 Re-sit	Other, please state
TYPE OF ASSESSMENT:	☐ Coursework		☒ Examination		☐ Practical
LANGUAGE OF ASSESSMENT:	ENGLISH		TRANSLATION REQUIRED (Y/N):	N	
FOR EXAMINATIONS ONLY. SPECIFY BELOW ANY ADDITIONAL MATERIAL(S) TO BE USED IN THE EXAMINATION					
This box will expand as you type					

INTERNAL MODERATOR PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ✓ YES NO		Comments
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation	✓		
2	Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)	✓		
3	Tasks which conform to the assessment described in the module syllabus	✓		
4	Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see http://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf?sfvrsn=170af781_14).	✓		
5	Clear criteria for assessment and guidance about how marking/grading will be applied	✓		
6	Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references			N/A
7	Reference to good academic conduct, for example referencing, plagiarism and Turnitin			N/A
8	Actions to complete			
This box will expand as you type				
SIGNATURE OF APPROVAL:		SIGNATURE		DATE
INTERNAL MODERATOR: I confirm that this version of the assessment specification is ready		Arenas		03/10/19.

**UNIVERSITY OF WALES:
TRINITY SAINT DAVID**



**PRIFYSGOL CYMRU:
Y DRINDOD DEWI SANT**

LOCATION: COLEG SIR GAR (GRAIG)

LLEOLIAD: COLEG SIR GAR (GRAIG)

LEVEL 4

LEFEL 4

**EXAMINATION PERIOD
AUGUST 2020**

**CYFNOD ARHOLIADAU
AWST 2020**

**MODULE CODE: SGDM4002
MECHANICAL SCIENCE 1**

TIME: 2 HOURS

**STUDENTS MUST ATTEMPT ALL QUESTIONS IN SECTION "A" AND ANY
THREE QUESTIONS FROM SECTION "B".**

Equipment or materials required

- *Calculators are permitted.*

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- *Caniateir cyfrifiannellau*

SECTION A

QUESTION ONE

- a. With the aid of a diagram, define shear stress and strain and state the units.
[5 marks]
- b. A cast iron block is 1m long and 0.5m wide. It has a depth of 0.01m. If the density of cast iron is 7800 kg/m^3 calculate its weight.
[5 marks]
- c. Define velocity and state the units.
[5 marks]
- d. Explain the difference between mass and weight. State the units of both terms.
[5 marks]
- e. A car has wheels of diameter, which are 0.4m. If the car travels 2km how many revolutions will the wheels complete?
[5 marks]

Total marks for Question 1 = 25 Marks

SECTION B

QUESTION TWO

For the beam shown in figure Q2, determine the shear force and bending moment equations and draw the shear force and bending moment diagrams.

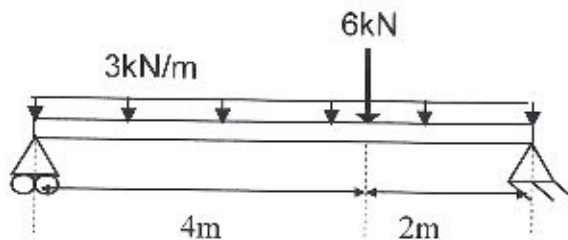


Figure Q2

Total marks for Question 2 = 25 marks

QUESTION THREE

A car travelling on level ground at 45 Km/hr when it accelerates uniformly to 120 Km/h in 15 seconds. If the car has a mass of 2 tonne and the brakes are applied so that the car comes to rest in a distance of 80 metres, calculate:

- (i) The accelerating force
- (ii) The braking force
- (iii) The power requirement as the car reaches maximum speed
- (iv) Sketch the motion on a velocity-time graph and use the diagram to calculate the distance travelled during the acceleration period.

Total marks for Question 3 = 25 marks

QUESTION FOUR

- a. A rectangular bar 50 mm wide, 10 mm thick and 500 mm long is subject to a tensile force of 60kN. If the bar is made of an aluminium alloy with a modulus of elasticity of 80GN/m^2 and a Poisson's ratio of 0.33, determine the changes in the linear dimensions of the bar.

[15 marks]

- b. An aluminium nail of radius 0.75mm projects horizontally outward from a wall. A man hangs a wet raincoat of mass of 2.6kg from the end of the nail. Assuming the wall holds its end of the nail and that no bending of the nail occurs, what is the total weight he can place in his pockets of his coat before the nail will shear and the coat fall to the floor? The shear strength of aluminium is 80MN/m^2 .

[10 marks]

Total marks for Question 4 = 25 marks

QUESTION FIVE

A particle moves with SHM making 7 complete oscillations in 11 seconds. When its distance from the centre of oscillation is 125mm its velocity is 1.25m/s. Find:

- the amplitude of vibration.
- the maximum velocity stating when this occurs
- the maximum acceleration stating when this occurs.

Total marks for Question 5 = 25 marks

DATA SHEET

Motion

$$v = u + at$$

$$s = ut + \frac{1}{2} at^2$$

$$v^2 = u^2 + 2as$$

$$s = \left(\frac{u+v}{2} \right) t$$

$$\omega_2 = \omega_1 + \alpha t$$

$$\theta = \omega_1 t + \frac{1}{2} \alpha t^2$$

$$\omega_2^2 = \omega_1^2 + 2\alpha\theta$$

$$\theta = \left(\frac{\omega_1 + \omega_2}{2} \right) t$$

$$v = \omega r, \quad a = \alpha r$$

$$s = \theta r$$

Elasticity

$$\sigma = \frac{P}{A}, \quad \epsilon = \frac{\delta L}{L}$$

$$E = \frac{\sigma}{\epsilon}$$

$$\nu = -\frac{\epsilon_{\text{lat}}}{\epsilon_{\text{long}}}$$

$$\tau = \frac{V}{A_R}, \quad G = \frac{\tau}{\gamma}$$

$$FOS = \frac{P_{\text{ultimate}}}{P_{\text{allowable}}} = \frac{\sigma_{\text{ultimate}}}{\sigma_{\text{allowable}}}$$

Bending and Torsion

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$Z = \frac{I}{y_{\text{max}}}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

Gear Ratio

$$\frac{\text{Speed of A}}{\text{Speed of B}} = \frac{\text{Teeth on B}}{\text{Teeth on A}}$$

Forces

$$F = \mu N$$

$$F = -kx$$

$$F = ma$$

SHM

$$T = \frac{2\pi}{\omega}, \quad f = \frac{1}{T}$$

$$\omega = 2\pi f$$

$$T = 2\pi \sqrt{\frac{l}{g}}$$

$$\frac{k}{m} = \frac{g}{\delta}$$

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{l}} = \sqrt{\frac{g}{\delta}}$$

$$v = -\omega \sqrt{r^2 - x^2}$$

$$v = -\omega r \sin \theta$$

$$a = -\omega^2 r \cos \theta$$

$$a = -\omega^2 r$$

Work, Energy and Power

$$WD = F \times s$$

$$P = \frac{WD}{t} = F \times v$$

$$PE = mgh$$

$$KE = \frac{1}{2} mv^2$$

Impulse and Momentum

$$F = \frac{m(v-u)}{t}$$

$$H_u = mu, \quad H_v = mv$$

$$J = F \times t$$

$$H_v = H_u + J$$

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

$$e = \frac{v_B - v_A}{u_A - u_B}$$

Thermodynamic Process

$$\text{Polytropic Process - } PV^n = C$$

$$\text{Work Transfer - } W = \frac{P_1 V_1 - P_2 V_2}{n-1}$$

$$\text{Isothermal Process - } W = P_1 V_1 \ln \frac{v_2}{v_1}$$

Perfect Gases

$$\text{Characteristic Gas Equation}$$

$$PV = mRT$$

$$\text{Other useful relationships -}$$

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2} \right)^{\frac{n-1}{n}}, \quad \frac{T_1}{T_2} = \left(\frac{v_2}{v_1} \right)^{n-1}$$

$$C_v = \left(\frac{du}{dT} \right)_p, \quad c_p = \left(\frac{dh}{dT} \right)_p$$

Steam and Properties of Vapours

$$\text{Enthalpy of wet steam} = hf + xhfg$$

$$\text{Specific volume of wet steam} = xvg$$

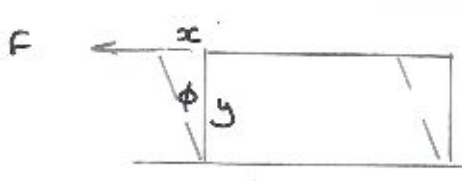
$$\text{Mass of vapour } m = \frac{V}{v}$$



EXAMINATION SOLUTIONS

(to accompany the examination paper sent to the external examiner
but NOT to be seen by students)

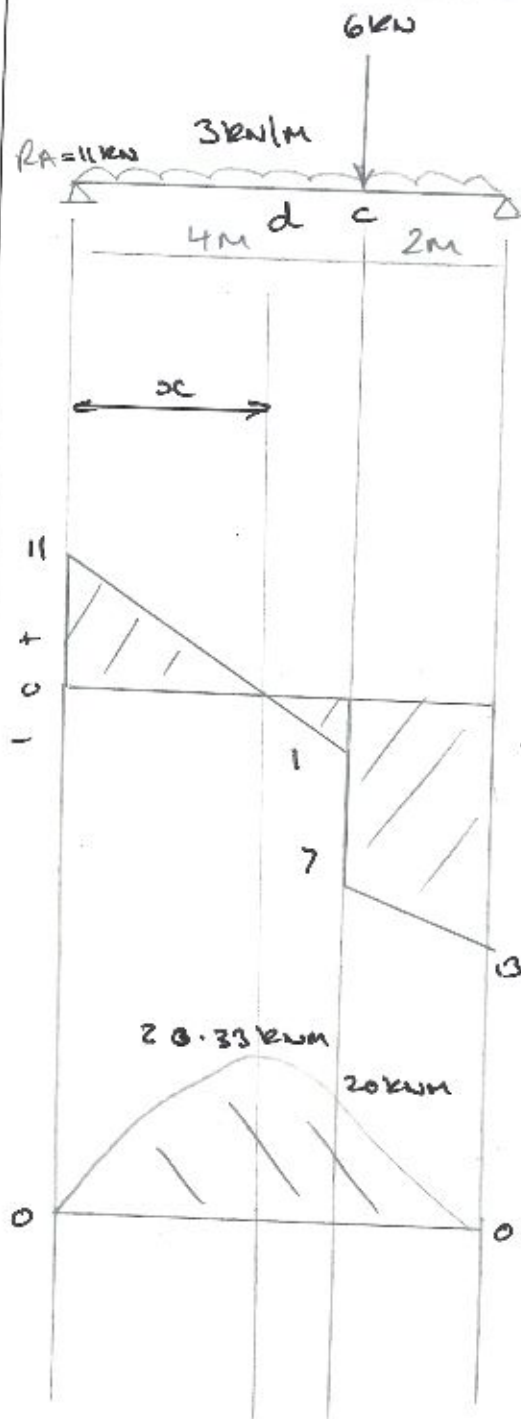
Programme:	HNC MECHANICAL ENGINEERING	Level:	4
Module:	SEDM4002 MECHANICAL SCIENCE 1	PART (MAIN)	
Author:	CHRIS DAVIES	Page:	1 /

Q1	Question	Marks
(a)	 $\tau = \frac{F}{A}$ OR $\tau = \frac{F}{A}$ (N/m²) MEAN UNDER STRESS $\tau = F/A$ (N/m²) SHEAR STRAIN = x/y NO UNIT	(3)
(b)	Volume = $1 \times 0.5 \times 0.01 = 0.005 \text{ m}^3$ $\rho = m/v \therefore m = \rho \times v$ $m = 7800 \times 0.005$ $m = 39 \text{ kg}$ $w = m \times g$ $w = 39 \times 9.81$ $w = 382.6 \text{ N}$	(2) (2) (1)
(c)	Velocity is the rate of change of distance with respect to time OR $v = ds/dt$ (m/s)	(5)
(d)	Mass is due to the composition of a body (matter present) UNIT = kg. Weight is due to composition and position (gravity) UNIT = N	(5)
(e)	$s = r\theta$ $\theta = s/r = \frac{2000}{0.2} = 10000 \text{ RADS}$ $\therefore \text{Revs} = 10000/2\pi = 1591.5$	(3) (2)

Q 2

Question

Marks



DETERMINE R_A & R_B

TAKE MOMENTS ABOUT R_A

C.W. = ACW MOMENT

$$(6 \times 4) + (3 \times 6 \times 3) = R_B \times 6$$

$$24 + 54 = 6R_B$$

$$78/6 = R_B$$

$$R_B = 13 \text{ kN}$$

$$\therefore R_A = 24 - 13$$

$$R_A = 11 \text{ kN}$$

(5)

$$\begin{cases} R_A = 11 \text{ kN} \\ R_B = 13 \text{ kN} \end{cases}$$

MAX S.F. = 13 kN

DRAW S.F. DIAGRAM & STATE MAX VALUE

(10)

DRAW B.M. DIAGRAM

& STATE MAX VALUE

MAX VALUE IS AT POINT 'D' ABOVE

$$S.F. \text{ at } D = 0$$

$$\therefore 11 - 3x = 0$$

$$11/3 = x \quad x = 3.67 \text{ m}$$

(5)

$$B.M. \text{ at } A = 0 \text{ Nm}$$

$$B.M. \text{ at } B = 0 \text{ Nm}$$

$$D.M. \text{ at } C = (1 \times 4) - (3 \times 4 \times 2) = 20 \text{ kNm}$$

$$B.M. \text{ at } D = (1 \times 3.67) - (3 \times 3.67 \times 3.67/2)$$

$$B.M. \text{ at } D = 20.33 \text{ kNm}$$

(5)

(10)

25

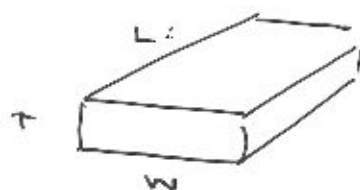
Q 3	Question	Marks
	$M = 2000 \text{ kg}$	(5)
	$u = 45 \text{ km/hr} = 45 \times \frac{1000}{3600} = 12.5 \text{ m/s}$	(1)
	$v = 120 \text{ km/hr} = 120 \times \frac{1000}{3600} = 33.3 \text{ m/s}$	(1)
(i)	$F = Ma \quad a = \frac{v - u}{t} = \frac{33.3 - 12.5}{15} = 1.39 \text{ m/s}^2$	(3)
	$\therefore F = 2000 \times 1.39 = 2773 \text{ N}$	(2)
(ii)	$F = Ma \quad a = \frac{v - u}{t} \quad \text{But } t = ?$ $\text{Now } s = \left(\frac{u+v}{2}\right)t \quad 80 = \left(\frac{33.3 + 0}{2}\right)t \quad \therefore t = 4.8 \text{ sec}$ $\therefore a = \frac{0 - 33.3}{4.8} \quad a = -6.9 \text{ m/s}^2$	(3)
	$\therefore F = 2000 \times 6.9 = 13800 \text{ N}$	(2)
(iii)	$P = F \times v \quad \therefore P = 2773 \times 33.3$ $P = 92.34 \text{ kW}$	(7)
(iv)	SEE ABOVE	

Q4

Question

Marks

(a)



$$\begin{aligned} L &= 500 \text{ mm} (0.5 \text{ m}) \\ T &= 10 \text{ mm} (0.01 \text{ m}) \\ W &= 50 \text{ mm} (0.05 \text{ m}) \\ F &= 60 \text{ kN} \quad E = 80 \text{ GN/m}^2 \\ \nu &= 0.33 \end{aligned}$$

$$Area = 0.01 \times 0.05 = 0.0005 \text{ m}^2$$

$$\sigma = \frac{F}{A} = \frac{60 \times 10^3}{0.0005} = 12 \text{ MN/m}^2$$

$$\epsilon = \frac{\sigma}{E} = \frac{12 \times 10^6}{80 \times 10^9} = 1.5 \times 10^{-4}$$

$$\begin{aligned} \therefore \Delta L &= \epsilon \times L \\ &= 1.5 \times 10^{-4} \times 0.5 \\ &= \underline{7.5 \times 10^{-5} \text{ m}} \end{aligned}$$

(2)

(2)

(2)

(1)

(2)

(b)



$$r = 0.75 \text{ mm}$$

$$W = 2.6 \text{ kg} = 2.6g \text{ N}$$

$$E = F/A \quad F = E \times A$$

$$F = 80 \times 10^6 \times (\pi r^2)$$

$$F = 80 \times 10^6 \times (\pi \times 0.00075^2)$$

$$F = 141.37 \text{ N}$$

$$\begin{aligned} \therefore \text{Additional weight} &= 141.37 - (2.6 \times 9.81) \\ &= \underline{115.8 \text{ N}} \end{aligned}$$

(3)

(4)

(3)

25

Q5	Question	Marks
	$\omega = 7/11 = 0.64 \text{ rad/s}$ $\omega = 0.64 \times 2\pi = 4 \text{ Rads/s}$	(4)
(a)	$v = \omega \sqrt{r^2 - x^2}$ $1.25 = 4 \sqrt{r^2 - 0.125^2}$ $\left(\frac{1.25}{4}\right)^2 = r^2 - 0.125^2$ $\sqrt{0.097 + 0.125^2} = r \quad \underline{r = 0.336 \text{ m}}$	(5)
(b)	$v_{\text{max}} = (4) \sqrt{0.336^2 - 0^2}$ MAX VELOCITY IS WHEN $x = 0$ $\therefore v_{\text{max}} = 4 \times 0.336 \quad \underline{v_{\text{max}} = 1.32 \text{ m/s}}$	(3) (5)
(c)	$a = \omega^2 x$ MAX ACCELERATION IS WHEN $x = 0.336 \text{ m}$ $\therefore a_{\text{max}} = (4)^2 \times 0.336 = \underline{5.73 \text{ m/s}^2}$	(3) (5)
		25