

## MODULE 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 include details for each assessment for a particular module. The assessment tasks, criteria and marking scheme should accompany this form. **NOTE: It is important that the Moderator and External Examiner see all the assessments tasks (including examination papers) for a module at the same time, to enable them to ensure that the proposed assessment tasks fulfil the learning outcomes.**

**UWTSD PROVISION:** please submit the completed document to the appropriate Programme Manager.

**COLLABORATIVE PROVISION:** please submit the completed document to the Partnership Team Leader. This must be in accord with specific arrangements for sharing electronic documents (e.g. via SharePoint or similar).

The assessment tasks, criteria and marking scheme **FOR EACH ASSESSMENT COMPONENT** within the module should accompany this form. **ONE APPROVAL FORM IS REQUIRED PER MODULE.**

|                                                                                                |                                     |                                                                |                                                                                   |
|------------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------|
| <b>PARTNER</b> (and taught location if relevant):                                              | COLLEGE 12345                       |                                                                |                                                                                   |
| <b>EXTERNAL EXAMINER NAME:</b>                                                                 | STEPHEN SIGURNIAK                   |                                                                |                                                                                   |
| <b>MODULE COORDINATOR:</b>                                                                     | CHRIS DAVIES                        |                                                                |                                                                                   |
| <b>MODULE TITLE:</b>                                                                           | SGEE4017 MECHANICAL ENGINEERING     |                                                                |                                                                                   |
| <b>MODULE CODE:</b>                                                                            | SGEE4017                            | <b>MODULE LEVEL:</b>                                           |                                                                                   |
| <b>TYPE OF ASSESSMENT(S):</b>                                                                  | <input type="checkbox"/> Coursework | <input checked="" type="checkbox"/> Examination<br>MAIN + REIT | <input type="checkbox"/> Practical                                                |
| <b>LANGUAGE OF ASSESSMENT(S):</b>                                                              | ENGLISH                             | <b>TRANSLATION REQUIRED</b>                                    | <input checked="" type="checkbox"/> Yes<br><input checked="" type="checkbox"/> No |
| <b>FOR EXAMINATIONS SPECIFY BELOW ANY ADDITIONAL MATERIAL(S) TO BE USED IN THE EXAMINATION</b> |                                     |                                                                |                                                                                   |
| This box will expand as you type                                                               |                                     |                                                                |                                                                                   |

| INTERNAL MODERATOR PLEASE TICK TO INDICATE THAT THE ASSESSMENTS INCLUDES: |                                                                                                                                                                                                                                                              | Please ✓<br>YES NO                  |                          | Comments |
|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------|----------|
| 1                                                                         | Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation                                                                                                                                      | <input checked="" type="checkbox"/> | <input type="checkbox"/> |          |
| 2                                                                         | Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)                                                                                                                                                              | <input checked="" type="checkbox"/> | <input type="checkbox"/> |          |
| 3                                                                         | Tasks which conform to the assessment described in the module syllabus                                                                                                                                                                                       | <input checked="" type="checkbox"/> | <input type="checkbox"/> |          |
| 4                                                                         | Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see <a href="https://www.qaa.ac.uk/the-quality-code/qualifications-frameworks">https://www.qaa.ac.uk/the-quality-code/qualifications-frameworks</a> ) | <input checked="" type="checkbox"/> | <input type="checkbox"/> |          |
| 5                                                                         | Clear criteria for assessment and guidance about how marking/grading will be applied                                                                                                                                                                         | <input checked="" type="checkbox"/> | <input type="checkbox"/> |          |
| 6                                                                         | Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references                                                                                                                                               | <input checked="" type="checkbox"/> | <input type="checkbox"/> |          |

|   |                                                                                      |                          |                          |          |
|---|--------------------------------------------------------------------------------------|--------------------------|--------------------------|----------|
| 7 | Reference to good academic conduct, for example referencing, plagiarism and Turnitin | <input type="checkbox"/> | <input type="checkbox"/> | N/A Exam |
| 8 | <b>Actions to complete</b><br><i>this box will expand as you type</i>                |                          |                          |          |

|                                                                                                                                                             |                                                                                   |             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------|
| <b>SIGNATURE OF APPROVAL:</b>                                                                                                                               | <b>SIGNATURE</b>                                                                  | <b>DATE</b> |
| <b>INTERNAL MODERATOR:</b> I confirm that this version of the assessment specification is ready to be sent to the External Examiner/Partnership Team Leader |  | 25.09.24    |

**ONLY TO BE COMPLETED IF THE ASSESSMENT IS LINKED TO A COLLABORATIVE PARTNER**

| <b>PARTNERSHIP TEAM LEADER PLEASE TICK TO INDICATE THAT THE ASSESSMENTS INCLUDES:</b> |                                                                                                                                                                                                                                                              | <b>Please ✓</b>          |                          | <b>Comments</b> |
|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|-----------------|
|                                                                                       |                                                                                                                                                                                                                                                              | <b>YES</b>               | <b>NO</b>                |                 |
| 1                                                                                     | Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation                                                                                                                                      | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 2                                                                                     | Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)                                                                                                                                                              | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 3                                                                                     | Tasks which conform to the assessment described in the module syllabus                                                                                                                                                                                       | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 4                                                                                     | Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see <a href="https://www.qaa.ac.uk/the-quality-code/qualifications-frameworks">https://www.qaa.ac.uk/the-quality-code/qualifications-frameworks</a> ) | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 5                                                                                     | Clear criteria for assessment and guidance about how marking/grading will be applied                                                                                                                                                                         | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 6                                                                                     | Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references                                                                                                                                               | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 7                                                                                     | Reference to good academic conduct, for example referencing, plagiarism and Turnitin                                                                                                                                                                         | <input type="checkbox"/> | <input type="checkbox"/> |                 |
| 8                                                                                     | <b>Actions to complete</b><br><i>this box will expand as you type</i>                                                                                                                                                                                        |                          |                          |                 |

|                                                                                                                      |                  |             |
|----------------------------------------------------------------------------------------------------------------------|------------------|-------------|
| <b>SIGNATURE OF APPROVAL:</b>                                                                                        | <b>SIGNATURE</b> | <b>DATE</b> |
| <b>PTL:</b> I confirm that this version of the assessment specification is ready to be sent to the External Examiner |                  |             |

**For completion by the External Examiner:**

This assessment specification has been subject to internal scrutiny and approval processes. As External Examiner, please consider and comment on its suitability. The assessment tasks, marking criteria and marking scheme accompany this form.

|                    | <b>EE Approval</b>       |                          | <b>EXTERNAL EXAMINER COMMENTS</b>       |
|--------------------|--------------------------|--------------------------|-----------------------------------------|
|                    | <b>YES</b>               | <b>NO</b>                |                                         |
| <b>FIRST DRAFT</b> | <input type="checkbox"/> | <input type="checkbox"/> |                                         |
|                    |                          |                          | <i>this box will expand as you type</i> |
|                    |                          |                          | <b>Signature and date:</b>              |

|                        |                          |                          |                                         |
|------------------------|--------------------------|--------------------------|-----------------------------------------|
| <b>FINAL<br/>DRAFT</b> | <input type="checkbox"/> | <input type="checkbox"/> | <i>this box will expand as you type</i> |
|                        |                          |                          | <b>Signature and date:</b>              |

**THIS DOCUMENT IS ALSO AVAILABLE IN WELSH**



**Prifysgol Cymru**  
Y Drindod Dewi Sant  
**University of Wales**  
Trinity Saint David

**LLEOLIAD: COLEG SIR GAR**

**LOCATION: COLEG SIR GAR**

**LEFEL 4**

**LEVEL 4**

**CYFNOD ARHOLIADA MAI 2025**

**EXAMINATION PERIOD MAY 2025**

**CÔD Y MODWL: SGEE4017**  
**MODULE CODE: SGEE4017**  
**MECHANICAL ENGINEERING**

**AMSER: 2 HOURS**  
**TIME: 2 HOURS**

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

*Equipment or materials required.*

*Adnoddau neu ddefnyddiau sydd eu hangen.*

*Cyfrifiannell/Calculator*

## QUESTION A

### QUESTION ONE

a. Sketch a typical stress vs strain graph obtained from a tensile test and highlight the following points of interest:

- (i) Elastic zone.
- (ii) Plastic zone.
- (iii) Yield stress.
- (iv) UTS.
- (v) Fracture point.

**[5 marks]**

b. The output power of a motor is 10 kW. How much work does it do in 40s?

**[5 marks]**

c. A car of mass 1000kg is climbing an incline at  $15^\circ$  to the horizontal. Determine the increase in potential energy of the car if it moves a distance of 100m up the incline.

**[5 marks]**

d. A pipe of diameter 200 mm contains an incompressible fluid running at a velocity of 2m/s. Determine volumetric flow rate within the pipe.

**[5 marks]**

e. Calculate the heat absorbed by a car radiator made of copper if its mass is 2kg and the temperature is increased  $10^\circ\text{C}$  to  $45^\circ\text{C}$  (take the specific heat capacity of copper as  $385\text{J/kgK}$ )

**[5 marks]**

**Total marks for Question 1 = 25 Marks**

## SECTION B

### QUESTION TWO

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

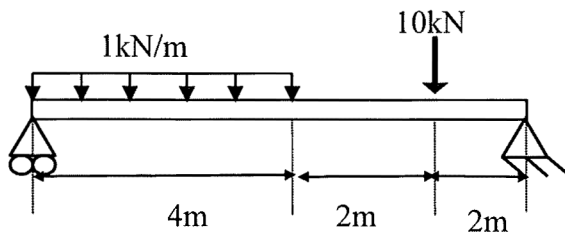


figure Q2

[25 Marks]

Total marks for Question 2 = 25 marks

### QUESTION THREE

- a) A metal rod of square cross-section, side length 25mm, is subjected to a tensile force of 100kN. The length of the rod before loading was 3m and afterwards it was found to be 3.012m. Assuming that the elastic limit has not been exceeded, find the value of Young's modulus for the material.

[15 marks]

- b) Find the force required to shear a bar of metal 40mm wide x 5mm thick. The ultimate shear stress of the metal is 385MN/m<sup>2</sup>.

[10 marks]

Total marks for Question 3 = 25 marks

#### QUESTION FOUR

a) State Newton's laws of motion.

[5 marks]

b) Explain what is meant by work, power, Potential Energy and Kinetic Energy.

[5 marks]

c) A motor car of mass 850kg travelling at 85km/hr has its brakes applied, which reduces its speed to 20km/hr. Calculate the change in kinetic energy. If the braking force required is constant at 350N, calculate the distance travelled during the speed reduction.

[10 marks]

d) A body of mass 50kg is oscillating in a horizontal straight line with simple harmonic motion. The amplitude of the oscillation is 1m and the periodic time for a complete oscillation is 10 secs. Calculate:

- i) The maximum force acting on the body.
- ii) The velocity of the body when it is 0.3m from the centre of oscillation

[5 marks]

**Total marks for Question 4 = 25 marks**

#### QUESTION FIVE

a) A vehicle starts from rest and accelerates at  $2.5\text{m/s}^2$  for 6.2 seconds. Calculate the velocity of the vehicle after 6.2 seconds and the distance covered in that time.

[12 marks]

b) A car engine increases its speed from 2000 rev/min to 4500 rev/min in 10 seconds. If the angular acceleration is constant over the time interval concerned, calculate:

- i) The initial and final angular velocity in rads/seconds.
- ii) The angular acceleration.
- iii) The number of revolutions made in 10 secs.

[13 marks]

**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

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

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

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

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

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

### 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

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

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

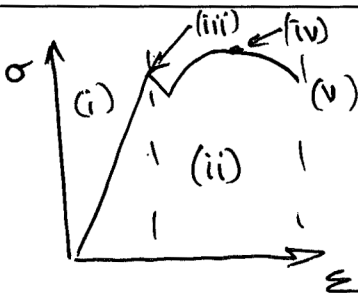
$$\text{Mass of vapour } m = \frac{V}{v}$$



## EXAMINATION SOLUTIONS

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

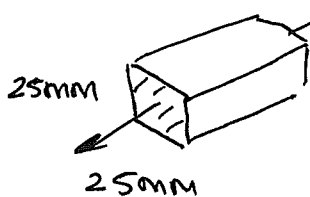
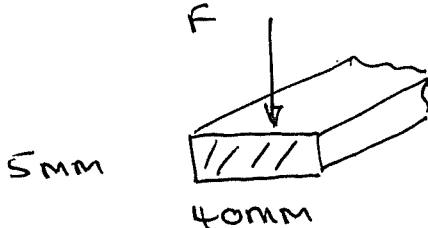
|            |                                          |        |       |
|------------|------------------------------------------|--------|-------|
| Programme: | HNC ELECTRICAL ENGINEERING               | Level: | 4     |
| Module:    | SGEE4017 (MECHANICAL ENGINEERING (MAIN)) |        |       |
| Author:    | CHRIS DANIEL                             | Page:  | 1 / 5 |

| Q1  | Question                                                                                                                                                                                                                                                                      | Marks                           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| (a) |  <p>(i) Elastic zone<br/>(ii) plastic zone<br/>(iii) yield stress<br/>(iv) UTR<br/>(v) fracture point</p>                                                                                   | (1)<br>(1)<br>(1)<br>(1)<br>(1) |
| (b) | $P = \frac{W \cdot D}{\text{Time}}$ - state formula<br>$10000 \times 40 = 400,000 \text{ J}$ - correct answer                                                                                                                                                                 | (1)<br>(4)                      |
| (c) | $PE = Mgh$ - states correct formula<br> $\sin 15 = \frac{h}{100}$ $h = 100 \times \sin 15$<br>$h = 25.88 \text{ m}$<br>$\therefore PE = 1000 \times 9.81 \times 25.88 = 253,882 \text{ J}$ | (1)<br>(2)<br>(2)               |
| (d) | $Q = CA$ - states correct formula<br>$Q = 2 \times (\pi \times 0.1^2)$<br>$Q = 0.063 \text{ m}^3/\text{s}$                                                                                                                                                                    | (1)<br>(4)                      |
| (e) | $Q = M \times C_p \times \Delta T$ (states correct formula)<br>$Q = 2 \times 385 \times 35$<br>$Q = 26,950 \text{ J}$                                                                                                                                                         | (1)<br>(4)                      |

25



| Q 2 | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marks                                        |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
|     | <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> </div> <div style="width: 50%;"> <p>Firstly determines <math>R_1</math> &amp; <math>R_2</math></p> <p>CW Moments = ACW Moments</p> <math display="block">(1 \times 4 \times 2) + (10 \times 6) = (R_2 \times 8)</math> <math display="block">8 + 60 = 8R_2</math> <math display="block">68/8 = R_2</math> <math display="block">R_2 = 8.5 \text{ kN}</math> <math display="block">\therefore R_1 = 14 - 8.5 = 5.5 \text{ kN}</math> <p>Max S.F. = 8.5 kN<br/>Draws diagram correctly</p> <p>B.M at ① = 0 kNm<br/>B.M at ② = 0 kNm<br/>B.M at ③ = <math>(5.5 \times 4) - (4 \times 2)</math><br/> <math display="block">= 14 \text{ kNm}</math><br/> B.M at ④ = <math>(5.5 \times 6) - (4 \times 4)</math><br/> <math display="block">= 17 \text{ kNm}</math><br/> Max B.M = 17 kNm<br/> Draws diagram correctly</p> </div> </div> | <p>(5)</p> <p>(10)</p> <p>(10)</p> <p>25</p> |

| Q 3 | Question                                                                                                                                                                                                                                                     | Marks     |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| (a) |  <p> <math>F = 100 \text{ kN}</math><br/> <math>\Delta L = 3.012 - 3</math><br/> <math>\Delta L = 0.012 \text{ m}</math><br/> <math>E = \frac{\sigma}{\epsilon}</math> </p> | (2)       |
|     | <p> <math>F = 100 \text{ kN}</math><br/> <math>\sigma = \frac{F}{A} = \frac{100,000}{25 \times 25} = 160 \text{ N/mm}^2</math> </p>                                                                                                                          | (4)       |
|     | <p> <math>\epsilon = \frac{\Delta L}{L} = \frac{0.012}{3} = 4 \times 10^{-3}</math> </p>                                                                                                                                                                     | (4)       |
|     | <p> <math>E = \frac{\sigma}{\epsilon} = \frac{160}{4 \times 10^{-3}} = 40,000 \text{ N/mm}^2</math><br/> or <u><u>40 GN/m<sup>2</sup></u></u> </p>                                                                                                           | (5)       |
| (b) |  <p> <math>\sigma_{ss} = 385 \text{ N/mm}^2</math><br/> or <math>385 \text{ MN/m}^2</math> </p>                                                                            | (2)       |
|     | <p> <math>I = \frac{F}{A}</math>      <math>F = I \times A</math> </p>                                                                                                                                                                                       |           |
|     | <p> Area under stress <math>= 0.04 \times 0.005</math><br/> <math>= 2 \times 10^{-4} \text{ m}^2</math> </p>                                                                                                                                                 | (3)       |
|     | <p> <math>F = I \times A</math><br/> <math>F = (385 \times 10^6) \times (2 \times 10^{-4})</math> </p>                                                                                                                                                       | (5)       |
|     | <p> <math>F = 77,000 \text{ N}</math> </p>                                                                                                                                                                                                                   | <u>10</u> |
|     |                                                                                                                                                                                                                                                              | <u>25</u> |



| Q 4 | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Marks                                       |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| (a) | <p>STATES 3 LAWS</p> <ul style="list-style-type: none"> <li>- First Law</li> <li>- Second Law</li> <li>- Third Law</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>(2)</p> <p>(2)</p> <p>(1)</p>            |
| (b) | <p>Defines w.D = Force <math>\times</math> Distance moved<br/>(5)</p> <p>Power = <math>\frac{w.D}{\text{TIME}}</math> (rate of doing work)<br/>(1)</p> <p>P.E (Energy possessed by virtue of position<br/>(5) above the ground) or <math>PE = mgh</math></p> <p>K.E (Energy possessed by virtue of motion<br/>(5) or <math>KE = \frac{1}{2}mv^2</math></p>                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>(2)</p> <p>(1)</p> <p>(1)</p>            |
| (c) | <p> <math>v = 80 \text{ km/hr} \rightarrow 20 \text{ m km/hr}</math><br/><math>m = 850 \text{ kg}</math></p> <p><math>\Delta K = \frac{1}{2}mu^2 - \frac{1}{2}mv^2</math></p> <p>Converts <math>80 \text{ km/hr} \Rightarrow 80 \times \frac{1000}{3600} = 22.2 \text{ m/s}</math></p> <p>Converts <math>20 \text{ km/hr} \Rightarrow 20 \times \frac{1000}{3600} = 5.56 \text{ m/s}</math></p> <p><math>\Delta K = \left[ \frac{1}{2} \times 850 \times (22.2)^2 \right] - \left[ \frac{1}{2} \times 850 \times (5.56)^2 \right]</math></p> <p><math>\Delta K = 209457 - 13138 = 196319 \text{ J}</math></p> <p><math>w.D = F \times s \quad \frac{196319}{350} = s = 560.9 \text{ m}</math></p> | <p>(2)</p> <p>(2)</p> <p>(3)</p> <p>(3)</p> |
| (d) | <p><math>m = 50 \text{ kg} \quad r = 1 \text{ m} \quad T = 10 \text{ secs} \quad (f = \frac{1}{10} = 0.1 \text{ Hz})</math></p> <p><math>F = kx \quad \&amp; \quad \omega = \sqrt{\frac{k}{m}} \quad 19.7</math></p> <p>(i) <math>(0.628)^2 \times 50 = k \quad k = 0.0125 \text{ N/m} \quad \therefore F = 0.0125 \times 1 = 0.0125 \text{ N}</math></p> <p>(ii) <math>v = \omega r \sqrt{r^2 - x^2} \quad v = 0.628 \sqrt{(1)^2 - (0.3)^2} = 0.6 \text{ m/s}</math></p>                                                                                                                                                                                                                                                                                                            | <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(2)</p> |

25

| Q 5  | Question                                                                                                                                                                                                                                                                          | Marks                     |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| (a)  | $u = 0 \text{ m/s}$ $a = 2.5 \text{ m/s}^2$ $t = 6.2 \text{ secs}$<br>$v = u + at$<br>$v = 0 + (2.5 \times 6.2)$<br>$v = \underline{15.5 \text{ m/s}}$<br>$s = \left(\frac{u+v}{2}\right)t$ $s = \left(\frac{0 + 15.5}{2}\right) \times 6.2$<br>$s = \underline{48.05 \text{ m}}$ | (2)<br><br>(5)<br><br>(5) |
| (b)  | $\omega_1 = 2000 \text{ rpm} \Rightarrow 2000 \times \frac{2\pi}{60} = \underline{209.3 \text{ rad/s}}$                                                                                                                                                                           | (3)                       |
| (i)  | $\omega_2 = 4500 \text{ rpm} \Rightarrow 4500 \times \frac{2\pi}{60} = \underline{471 \text{ rad/s}}$<br>$t = 10 \text{ secs}$                                                                                                                                                    |                           |
| (ii) | $\omega_2 = \omega_1 + \alpha t$<br>$471 = 209.3 + 10\alpha$<br>$\frac{471 - 209.3}{10} = \alpha$ $\alpha = \underline{26.17 \text{ Rad/s}^2}$                                                                                                                                    | (5)                       |
|      | $\theta = \left(\frac{\omega_2 + \omega_1}{2}\right)t$ $\theta = \left(\frac{471 + 209.3}{2}\right) \times 10$<br>$\theta = \underline{3401.5 \text{ Rads}}$                                                                                                                      | (4)                       |
|      | $\theta = \frac{3401.5}{2\pi}$ $\theta = \underline{\underline{542 \text{ Revs}}}$                                                                                                                                                                                                | (1)                       |
|      |                                                                                                                                                                                                                                                                                   | 25                        |

**LLEOLIAD: COLEG SIR GAR**

**LOCATION: COLEG SIR GAR**

**LEFEL 4**

**LEVEL 4**

**CYFNOD ARHOLIADA AWST 2025**

**EXAMINATION PERIOD AUGUST 2025**

**CÔD Y MODWL: SGEE4017**  
**MODULE CODE: SGEE4017**  
**MECHANICAL ENGINEERING**

**AMSER: 2 HOURS**  
**TIME: 2 HOURS**

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

*Equipment or materials required.*

*Adnoddau neu ddefnyddiau sydd eu hangen.*

*Cyfrifiannell/Calculator*

## **QUESTION A**

### **QUESTION ONE**

a. Define Poisson's ratio.

**[5 marks]**

b. Define the modulus of rigidity and state the units used.

**[5 marks]**

c. A car mass of 1250kg must be accelerated at a rate of  $1.5\text{m/s}^2$ . Determine the force required.

**[5 marks]**

d. Calculate the gauge pressure at a point submerged to a depth of 10m in fresh water. Assume the density of water is  $1000\text{ kg/m}^3$ .

**[5 marks]**

e. Determine the volume of a container needed to house 15000kg of water if its density is  $1020\text{kg/m}^3$ . Also, determine the weight of the water.

**[5 marks]**

**Total marks for Question 1 = 25 Marks**

## SECTION B

### QUESTION TWO

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

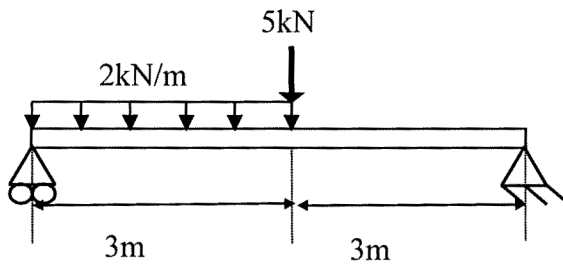


figure Q2

[25 Marks]

Total marks for Question 2 = 25 marks

### QUESTION THREE

a) Calculate the change in diameter of a steel bar subjected to a tensile force of 15kN, given that the original diameter was 25mm,  $E$  for steel is  $207\text{GN/m}^2$  and Poisson's ratio is 0.3

[15 marks]

b) A punch presses out circular disks from material that has a thickness of 2.5mm. If the diameter of the disk is 100mm, calculate the force required to punch out the disk. The ultimate shear strength of the material is  $450\text{MN/m}^2$

[10 marks]

Total marks for Question 3 = 25 marks

### QUESTION FOUR

- a) A mass of 10kg is raised to a height of 5m. If the mass is released, find its kinetic energy and its velocity as it hits the ground.

**[10 marks]**

- b) An electric motor provides power to a winding machine. The input power to the motor is 3kW and the overall efficiency is 60%. Calculate:

- (i) The output power of the machine
- (ii) The rate at which it can raise a 300kg load vertically upwards.

**[9 marks]**

- c) A body of mass 10kg moves with Simple Harmonic Motion (SHM) in a straight line, and the maximum force acting on it is 300N. If the amplitude is 0.8m, determine:

- (i) the maximum acceleration of the body
- (ii) the periodic time of the motion
- (iii) the maximum velocity of the body.

**[6 marks]**

**Total marks for Question 4 = 25 marks**

## **QUESTION FIVE**

- a) A car of mass 950kg travelling at 75km/h. Determine the necessary braking force if the car is to be brought to rest in distance of 60m. Also, determine the time required for the car to stop.

**[13 marks]**

- b) A flywheel increases its speed from 30 to 60rev/min in 15 seconds. The diameter of the wheel is 2.5m. Calculate:

- (i) the angular acceleration
- (ii) the number of revolutions made during the 15 seconds
- (iii) the linear acceleration of a point on the rim of the flywheel.

**[12 marks]**

**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

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

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

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

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

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

### 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

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

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

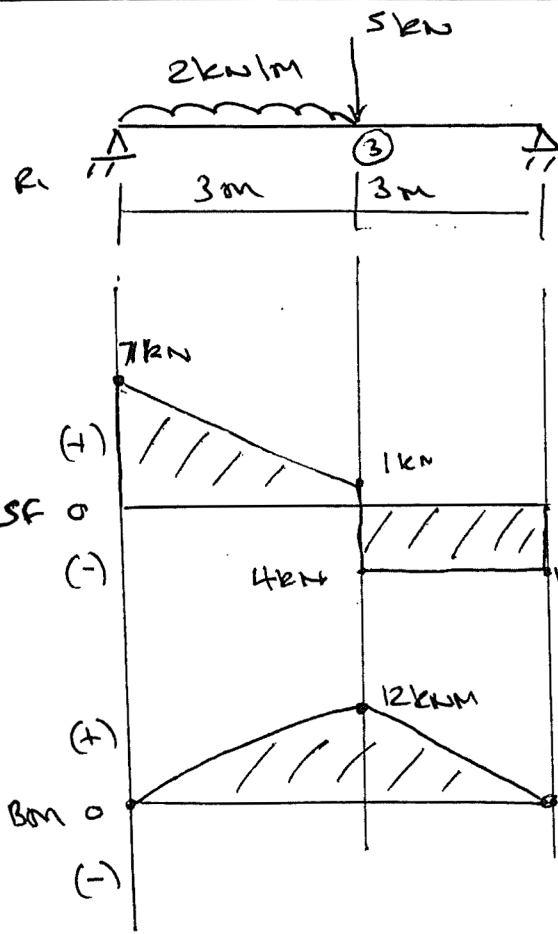
$$\text{Mass of vapour } m = \frac{V}{v}$$

# EXAMINATION SOLUTIONS

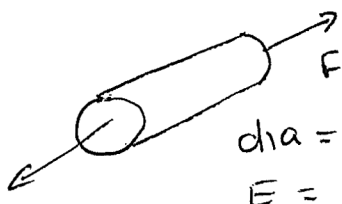
(to accompany the examination paper sent to the external examiner  
but NOT to be seen by students)

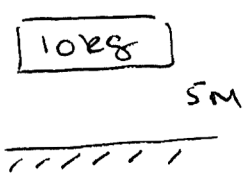
|            |                                          |        |       |
|------------|------------------------------------------|--------|-------|
| Programme: | HNC ELECTRICAL ENGINEERING               | Level: | 4     |
| Module:    | SGEE4017 MECHANICAL ENGINEERING (RESULT) |        |       |
| Author:    | CHRIS DAVIES                             | Page:  | 1 / 5 |

| Q 1 | Question                                                                                                                                                                                                    | Marks              |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| (a) | $\nu = \frac{\epsilon_r}{\epsilon_L}$ or Ratio of transverse strain to longitudinal strain                                                                                                                  | (5)                |
| (b) | $G = \tau / \phi = \frac{\text{shear stress (N/mm}^2\text{)}}{\text{shear strain}}$                                                                                                                         | (3)                |
| (c) | $F = ma$ (states correct formula)<br>$F = 1250 \times 1.5$<br>$F = 1875 \text{ (N)}$                                                                                                                        | (1)<br>(4)         |
| (d) | $p = \rho gh$ (states correct formula)<br>$p = 1000 \times 9.81 \times 10$<br>$p = 98100 \text{ N/m}^2$                                                                                                     | (1)<br>(4)         |
| (e) | $m = 15000 \text{ kg}$ $\rho = 1020 \text{ kg/m}^3$<br>$p = \frac{m}{V}$ $V = \frac{m}{\rho} = \frac{15000}{1020} = 14.7 \text{ m}^3$<br><br>$w = mg$<br>$w = 15000 \times 9.81$<br>$w = 147,150 \text{ N}$ | (3)<br><br><br>(2) |
|     |                                                                                                                                                                                                             | <u>25</u>          |

| Q 2 | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marks                                               |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|
|     | <div>  </div> <div> <p>Determines <math>R_1</math> &amp; <math>R_2</math></p> <math display="block">(2 \times 3 \times 1.5) + (5 \times 3) = (R_2 \times 6)</math> <math display="block">9 + 15 = 6R_2</math> <math display="block">24/6 = R_2</math> <math display="block">R_2 = 4 \text{ kN}</math> <math display="block">\therefore R_1 = 15 - 4 = \underline{\underline{11 \text{ kN}}}</math> </div> <div> <p>correctly draws the S.F diagram &amp; states Max S.F = <u>7 kN</u></p> </div> <div> <p>correctly draws the B.M diagram &amp; states Max B.M =</p> </div> <div> <p>B.M at ① = 0 Nm<br/>B.M at ② = 0 Nm<br/>B.M at ③ = <math>(7 \times 3) - (6 \times 1.5)</math><br/><math>= 21 - 9</math><br/><math>= \underline{\underline{12 \text{ kNm}}}</math></p> </div> | <p>(5)</p> <p>(10)</p> <p>(10)</p> <p><u>25</u></p> |

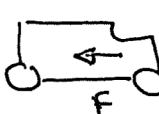


| Q 3 | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Marks                                                  |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| (a) |  <p> <math>F = 15 \text{ kN}</math><br/> <math>\text{dia} = 25 \text{ mm}</math><br/> <math>E = 207 \text{ GPa}</math><br/> <math>\nu = 0.3</math> </p> <p> <math>\sigma = \frac{F}{A} = \frac{15000}{(\pi \times 12.5^2)} = 30.55 \text{ N/mm}^2</math> </p> <p> <math>\epsilon_L = \frac{\sigma}{E} = \frac{30.55}{207 \times 10^3} = 0.000148</math> </p> <p> <math>\nu = \frac{\epsilon_T}{\epsilon_L} \quad \epsilon_T = \nu \times \epsilon_L \Rightarrow 0.3 \times 0.000148</math><br/> <math>\epsilon_T = 0.000044</math> </p> <p> <math>\therefore 0.000044 \times 25 = \Delta D \quad \Delta D = 0.0011 \text{ mm}</math> </p> | <p>(2)</p> <p>(3)</p> <p>(3)</p> <p>(3)</p> <p>(4)</p> |
| (b) |  <p> <math>\text{dia} = 100 \text{ mm}</math><br/> <math>t = 2.5 \text{ mm}</math><br/> <math>G = 450 \text{ MN/m}^2</math> </p> <p> <math>\tau = \frac{F}{A} \quad F = \tau \times A</math> </p> <p> <math>\text{Area under shear} = \pi D t</math><br/> <math>= \pi \times 100 \times 2.5</math><br/> <math>= 785.5 \text{ mm}^2</math> </p> <p> <math>\therefore F = 450 \times 785.5</math><br/> <math>F = 353,475 \text{ N}</math> </p>                                                                                                                                                                                            | <p>(2)</p> <p>(4)</p> <p>(4)</p> <p><u>Σ = 25</u></p>  |

| Q 4   | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| (a)   | <div style="display: flex; align-items: center;"> <div style="text-align: center; margin-right: 20px;">  <p>10kg<br/>5m</p> </div> <div> <math>PE = mgh = 10 \times 9.81 \times 5</math><br/> <math>= 490.5 \text{ J}</math><br/> <math>KE = PE = 490.5</math><br/> <math>490.5 = 0.5 mv^2</math><br/> <math>\frac{490.5}{0.5 \times 10} = v^2 \quad v = \underline{9.9 \text{ m/s}}</math> </div> </div>              | (5)   |
| (b)   | <div style="display: flex; align-items: center;"> <div style="text-align: center; margin-right: 20px;">  </div> <div> <math>P = 3 \text{ kW}</math><br/> <math>\eta = 60\%</math><br/> <math>P_{out} = 3 \times 0.6 = \underline{1.8 \text{ kW}}</math><br/> <math>P = \text{Force} \times \text{vel}</math><br/> <math>\frac{1800}{(300 \times 9.81)} = v \quad v = \underline{0.61 \text{ m/s}}</math> </div> </div> | (3)   |
| (c)   | $M = 10 \text{ kg} \quad F_{max} = 300 \text{ N} \quad r = 0.8 \text{ m}$                                                                                                                                                                                                                                                                                                                                                                                                                               |       |
| (i)   | $a = \omega_n^2 x_c \quad \& \quad f = k/x_c \quad k = \frac{F}{x_c} = \frac{300}{0.8} = 375 \text{ N/m}$<br>$\omega_n = \sqrt{\frac{k}{M}} \quad \omega_n = \sqrt{\frac{375}{10}} \quad \omega_n = \underline{6.1 \text{ Rads/s}}$<br>$a = (6.1)^2 \times 0.8 \quad a = \underline{29.8 \text{ m/s}^2}$                                                                                                                                                                                                | (3)   |
| (ii)  | $\omega_n = 6.1 \text{ Rads/s} \Rightarrow \frac{6.1}{2\pi} = 0.97 \text{ Hz} \quad T = \frac{1}{f} = \frac{1}{0.97}$<br>$T = \underline{1.03 \text{ Sec}}$                                                                                                                                                                                                                                                                                                                                             | (1)   |
| (iii) | $V_{max} \text{ when } x_c = 0$<br>$V = \omega_n \sqrt{r^2 - x_c^2}$<br>$V = 6.1 \sqrt{(0.8)^2} = \underline{4.88 \text{ m/s}}$                                                                                                                                                                                                                                                                                                                                                                         | (1)   |

$\Sigma = 25$



| Q 5   | Question                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Marks                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| (a)   |  $m = 950 \text{ kg}$ $v = 75 \text{ km/hr}$ <p>Stopping distance = 60m.</p> $v = 75 \times \frac{1000}{3600} = 20.83 \text{ m/s}$ $u = v = 20.83 \text{ m/s} \quad v = 0 \text{ m/s} \quad s = 60 \text{ m}$ <p>Now <math>v^2 = u^2 + 2as</math></p> $0^2 - (20.83^2) = a \quad a = 3.6 \text{ m/s}^2$ $\therefore F = ma \quad F = 950 \times 3.6$ $F = 3420 \text{ N}$ | <p>(1)</p> <p>(2)</p> <p>(5)</p> <p>(5)</p> <p><u>13</u></p> |
| (b)   | $\omega_1 = 30 \text{ rpm} \quad t = 15 \text{ secs}$ $\omega_2 = 60 \text{ rpm} \quad \text{dia} = 2.5 \text{ m}$ <p>Converts both in Rads/s</p> $30 \times \frac{2\pi}{60} = 3.14 \text{ Rads} \quad 60 \times \frac{2\pi}{60} = 6.28 \text{ Rads/s}$                                                                                                                                                                                                    | <p>(2)</p> <p>(2)</p>                                        |
| (i)   | $\omega_2 = \omega_1 + \alpha t \quad \alpha = \frac{6.28 - 3.14}{15} = 0.21 \text{ Rads/s}^2$                                                                                                                                                                                                                                                                                                                                                             | (3)                                                          |
| (ii)  | $\theta = \left( \frac{\omega_1 + \omega_2}{2} \right) t \quad \theta = \left( \frac{3.14 + 6.28}{2} \right) \times 15$ $\theta = 70.65 \text{ Rads} \Rightarrow \frac{70.65}{2\pi} = 11.25 \text{ Revs}$                                                                                                                                                                                                                                                  | <p>(3)</p>                                                   |
| (iii) | $v = \omega r \quad a = \alpha r$ $a = 0.21 \times 1.25$ $a = 0.26 \text{ m/s}^2$                                                                                                                                                                                                                                                                                                                                                                          | <p>(2)</p> <p><u>12</u></p>                                  |

Σ = 25

(5)