UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, APRIL/MAY 2019

COURSE NO: GL/MN/MR/PE/ES/MC/EL/RN 152
COURSE NAME: STRENGTH OF MATERIALS
CLASS: GL/MN/MR/PE/ES/MC/EL/RN I **TIME**: 3 HRS

Name**:** _____Index Number: _____

INSTRUCTIONS

*Attempt **ALL** questions (marks for each is indicated beside each question).*
Full credits will be given to clear and logical presentation of solution. Whenever necessary, draw simple diagrams, state the principle or theory being applied, and/or assumptions made.

Section A [30 marks]

1. To avoid failure in structural elements, which of the following conditions must be satisfied
   a) Allowable stress ≤ maximum induced stress
   b) Maximum induced stress ≤ Allowable stress
   c) Maximum induced stress ≥ Allowable stress
   d) Allowable stress = Maximum induced stress
   e) None of the above
2. If the percentage elongation of a material is equal or greater than 10 % then the material is classified as;
   a) Brittle
   b) Ductile
   c) Malleable
   d) Fragile
   e) None of the above
3. Which of the following materials can be classified as a ductile material
   a) Stone
   b) Cast iron
   c) Ceramic
   d) Concrete
   e) None of the above
4. Which of the following cannot be negative
   a) Tensile stress
   b) Tensile strain
   c) Moment of inertia
   d) Centroid
   e) None of the above
5. If a materials expands freely due to heating it will develop
   a) Thermal stresses
   b) Tensile stresses
   c) Bending
   d) Compressive stress
   e) No stress
6. The stress at which extension of the material takes place more quickly as compared to the increase in load is called
   a) Elastic point of the material
   b) Plastic point of the material
   c) Breaking point of the material
   d) Yielding point of the material
   e) Ultimate point of the material
7. Which of the following materials has it poison's ratio to be greater than unity?
   a) Steel
   b) Copper
   c) Aluminium
   d) Cast iron
   e) None of the above

8. A steel bar 2.5 m long has circular cross-section of diameter d_1 = 22 mm over one-half of its length and diameter d_2 = 10 mm over the other half. How much will the bar elongate under a compressive load P = 20 kN, if E of the bar is 200 GPa?
   a) 1.92 m
   b) 1.92 cm
   c) 1.92 mm
   d) 0.83 mm
   e) None of the above
9. The maximum theoretical value of Poison's ratio is
   a) 0.025
   b) 0.250
   c) 0.050
   d) 0.500
   e) None of the above
10. Highest value of stress for which Hooke's law is applicable for given material is called
   a) Stress limit
   b) Strain limit
   c) Proportional limit
   d) Significant limit
   e) None of the above
11. The ability of a material to absorb energy without fracture is known as
   a) Resilience
   b) Robustness
   c) Toughness
   d) Stiffness
   e) None of the above
12. The slope of the linear portion of the shear stress-strain diagram is known as
   a) Modulus of elasticity
   b) Young's modulus
   c) Bulk modulus
   d) Modulus of rigidity
   e) None of the above
13. A hollow cylinder 4 m long has outside and inside diameters of 75 mm and 60 mm respectively. Find the deformation of the cylinder, when it is carrying an axial tensile load of 50 kN. Take E = 100 GPa.
   a) 0.126 mm
   b) 1.260 mm
   c) 12.60 mm
   d) 1.260 m
   e) None of the above
14. The centre of gravity of an equilateral triangle with each side ***b*** cm is ……..from any of the three sides.
   a) $\frac{b\sqrt{3}}{2}$
   b) $\frac{b\sqrt{2}}{3}$
   c) $\frac{b}{2\sqrt{3}}$
   d) $\frac{b}{3\sqrt{2}}$
   e) None of the above
15. Determine the polar moment of inertia of a shaft with 150 mm diameter shaft running at 240 rev/min which can withstand a maximum permissible shear stress of 50 N/mm^2.
   a) 4970.7421 mm^4
   b) 4970.7421 cm^4
   c) 2565.5444 mm^4
   d) 2565.5444 cm^4
   e) None of the above
16. A load of 5 kN is to be raised with the help of a steel wire. Find the minimum diameter of wire, if the stress is not to exceed 100 MPa.
   a) 0.5 mm
   b) 0.5 cm
   c) 1 mm
   d) 1 cm
   e) None of the above
17. A copper bar of length 2 m is at a temperature of -10°C. If the material properties are; E = 200 GPa and α = 12 x 10^{-6}/K. Find the new length of the bar when it is heated to 50°C.

a) 20001.44 mm
b) 2001.44 mm
c) 2000.96 mm
d) 2009.60 mm
e) None of the above

18. Determine the diameter of a solid steel shaft which can transmit 50 kW at 60 rev/min if the maximum shear stress is not to exceed 50 MPa.
a) 9.323 cm
b) 93.23 cm
c) 932.3 cm
d) 9323 cm
e) None of the above

19. The ratio of linear strain to lateral strain is called
a) Modulus of elasticity
b) Modulus of rigidity
c) Bulk modulus
d) Poisson's ratio
e) None of the above

20. It is desired to transmit 90 kW by means of a solid circular shaft rotating at 3.5 rev/s. the allowable shearing stress is 45 MPa. Find the required shaft diameter.
a) 0.0774 cm
b) 0.7740 cm
c) 7.7740 cm
d) 77.740 cm
e) None of the above

21. Find the moment of inertia of a rectangular section 100 mm wide and 60 mm deep about an axis coinciding with the base
a) 1 800 000 mm^4
b) 7 200 000 mm^4
c) 5 000 000 mm^4
d) 20 000 00 mm^4
e) None of the above

22. Determine the moment of inertia through the vertical centroidal axis of a rectangle with a base of 120 mm and a height of 100 mm.
a) 57 600 000 mm^4
b) 14 400 000 mm^4
c) 40 000 000 mm^4
d) 10 000 000 mm^4
e) None of the above

23. Which of the following can have both negative and positive values
a) Force
b) Centre of gravity
c) First moment of area
d) Second moment of area
e) None of the above

24. Where will be the centre of gravity of the T section shown in the figure 1?
a) 8 cm
b) 8.5 cm
c) 10.5 cm
d) 11.5 cm
e) None of the above

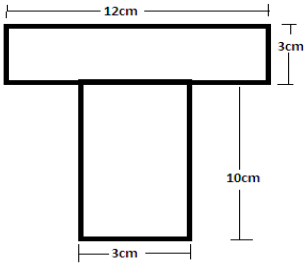

Figure 1

25. If the radius of wire stretched by a load is doubled, then its Young's modulus will be
a) doubled
b) halved
c) become four times
d) become one-fourth
e) none of the above

26. A solid circular shaft is required to transmit 200 kW while turning at 1.5 rev/s. the allowable shearing stress is 42 MPa. The required shaft diameter would be approximately;
    a) 12 cm
    b) 14 cm
    c) 16 cm
    d) 18 cm
    e) None of the above
27. A propeller shaft in a ship is 350 mm in diameter. The allowable working stress in shear is 50 MPa and the allowable angle of twist is 1° in 15 diameters of length. If G = 85 GPa, determine the maximum torque the shaft can transmit.
    a) 316 kNm
    b) 380 kNm
    c) 416 kNm
    d) 466 kNm
    e) None of the above
28. Which of the following beams can be considered as a statically indeterminate beam
    a) A beam with two supports
    b) A cantilever
    c) An overhanging beam
    d) A simple beam
    e) None of the above

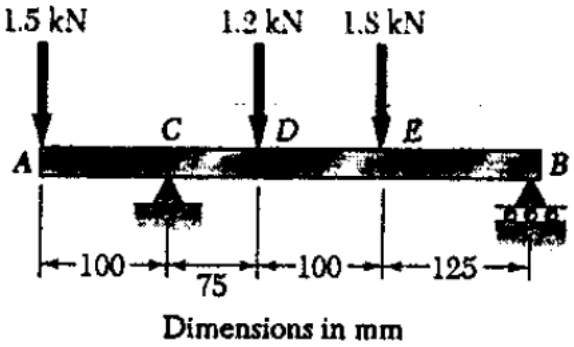

Figure 2

29. Determine the reaction at point B, R_B in figure 2;
    a) 3.65 kN
    b) 3.50 kN
    c) 2.50 kN
    d) 0.85 kN
    e) None of the above
30. Determine the reaction at point C, R_C in figure 2;
    a) 3.65 kN
    b) 3.50 kN
    c) 2.50 kN
    d) 0.85 kN
    e) None of the above

Section B [30 Marks]

Question 1 [10 marks]

A. A nylon thread is subjected to a 8.5 N tension force. Knowing that E = 3.3 GPa and that the length of the thread increases by 1.1 %, determine the diameter of the thread and the stress in the thread. [4 marks]

B. A single axial load of magnitude P = 58 kN is applied at end C of the brass road ABC as shown in figure 3. Knowing that E = 105 GPa, determine the diameter d of portion BC for which the deflection of point C will be 3 mm. [6 marks]

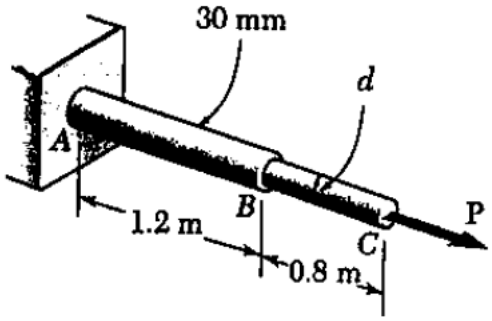

Figure 3

Question 2 [10 marks]

A. Determine the centroid of the area shown in figure 4 below. [4 marks]

B. Calculate the moment of inertia passing through the vertical axis of the centroid. [6 marks]

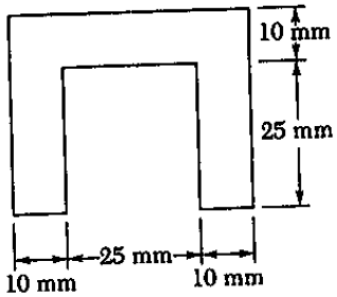

Figure 4

Question 3 [10 marks]

Draw a shear force and bending moment diagrams for the beam shown in figure 5. Indicate all the necessary points on the diagrams.

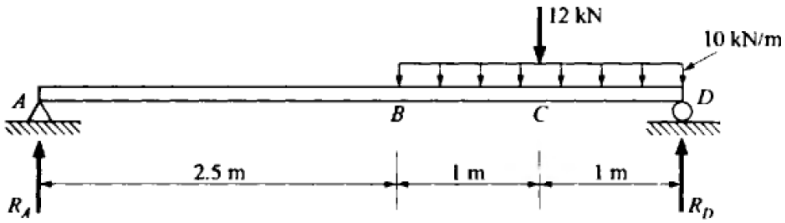

Figure 5

Examiners: Mr E. Seckley/N. Yakah/D. Yellezoume