UGANDA INSTITUTE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
END OF SEMESTER ONE EXAMINATIONS

ACADEMIC YEAR 2024/2025

DEPARTMENT: ICT

SEMESTER: ONE

PROGRAMME(S): DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING (DEEE)

YEAR OF STUDY: ONE

COURSE: ENGINEERING MECHANICS

COURSE CODE : EMC111

DATE: THURSDAY 12TH, DECEMBER 2024

TIME: 9:00 AM – 12:00 NOON

DURATION: 3 HOURS

INSTRUCTIONS:

(i) This paper contains two Sections: A (40 marks) & B (60 marks).

(ii) Attempt ALL questions in Section A, and ONLY THREE questions in Section B.

(iii) All questions in Section B carry equal marks.

(iv) Credit will be given for use of relevant examples and illustrations.

(v) Begin each number in Section B on a new page of the answer sheet.

(vi) DO NOT write on this question paper.

SECTION A [40 MARKS]

Attempt **ALL** the Questions in this Section.

For questions 1 to 10 write the correct alternative in the answer booklet provided

(2 marks @)

1. In a 4-stroke engine, how many revolutions of the crankshaft are required to complete one cycle?
   A. 1 B. 2 C. 4 D. 6

2. A spark ignition engine typically uses which type of fuel?
   A. Diesel B. Gasoline C. Kerosene D. Natural gas

3. The purpose of the cooling system in an engine is to:
   A. Lubricate engine parts
   B. Prevent overheating
   C. Increase combustion efficiency
   D. Supply air-fuel mixture

4. The primary purpose of a beam in structural systems is to resist:
   A. Axial loads
   B. Shear forces and bending moments
   C. Torsion
   D. Compression only

5. Which of the following is a measure of a material's stiffness?
   A. Young's modulus
   B. Poisson's ratio
   C. Shear modulus
   D. Bulk modulus

6. A beam that is rigidly fixed at both ends is called a:
   A. Simply supported beam
   B. Fixed beam
   C. Cantilever beam
   D. Overhanging beam

7. The type of beam designed to support a single concentrated load is:
   A. Fixed beam
   B. Simply supported beam
   C. Cantilever beam
   D. Overhanging beam

8. A load that acts at a single point on a beam is known as:
   A. Uniform load
   B. Point load
   C. Line load
   D. Distributed load

9. The coefficient of friction depends on:

A. Surface materials
B. Surface roughness
C. Both A and B
D. Neither A nor B

10. The transition from static friction to kinetic friction is known as:
A. Limiting friction
B. Viscous drag
C. Dynamic equilibrium
D. Lubrication threshold

11. Which type of friction occurs between stationary objects?
A. Rolling friction B. Static friction C. Dynamic friction D. Fluid friction

12. The coefficient of friction is the ratio of:
A. Normal force to friction force
B. Friction force to normal force
C. Tension to normal force
D. Load to reaction force

13. Hooke's Law is valid only in the:
A. Elastic limit B. Plastic limit C. Proportional limit D. Ultimate stress point

14. What happens at the yield point in a stress-strain graph?
A. Elastic deformation starts
B. Plastic deformation starts
C. Breaking stress is reached
D. No deformation occurs

15. What force acts perpendicular to the length of a beam?
A. Axial force B. Shear force C. Torsional force D. Compressive force

16. Which of the following materials exhibits the highest elastic limit?
A. Steel B. Rubber C. Aluminum D. Copper

17. When a material undergoes plastic deformation, it:
A. Returns to its original shape after the load is removed
B. Breaks immediately
C. Does not return to its original shape after the load is removed
D. Remains unchanged

18. The ratio of lateral strain to longitudinal strain in a material is called:
A. Young's modulus
B. Poisson's ratio
C. Bulk modulus
D. Modulus of rigidity

19. A load applied at the support of a beam is called:
A. A point load
B. A reaction load
C. A distributed load
D. A moment load

20. A point load acting at the midpoint of a simply supported beam will produce a bending moment that is:

A. Maximum at the supports
B. Maximum at the midpoint
C. Zero at the midpoint
D. Uniform along the length

SECTION B [60 MARKS]

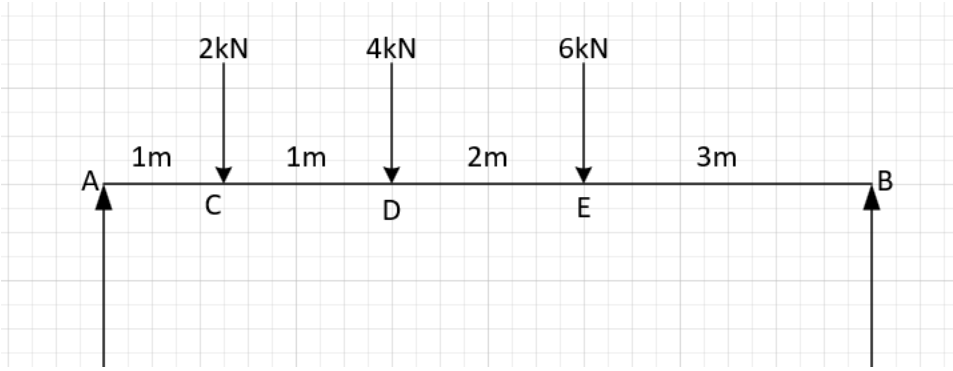
Attempt **ONLY THREE** Questions in this Section.

Question 1

a) Define the term Poisson's ratio **(2 marks)**
b) Show that the theoretical limiting values of Poisson's ratio are -1 and 0.5 **(5 marks)**
c) Derive expressions for Poisson's ratio in terms of elastic constants. (10 marks)
d) Find the Poisson's ratio for the material, given Young's modulus E= 1.225x1011 Nm^{-2} , modulus of rigidity G= 4.55x1010 Nm **(3 marks)**

Question 2

a) Describe the various types of loadings in beams? **(6 marks)**
b) Distinguish between statically determinate beams and statically indeterminate beams **(4 marks)**
c) A simply supported beam of 7 m length carries point loads 2 kN, 4 kN and 6 kN at distances of 1 m, 2 m and 4 m from the fixed end respectively as shown in the diagram .Draw Shear force and Bending moment diagram. **(10 marks)**



Question 3

a) Explain the following material properties:
   i) Elasticity.
   ii) Tensile stress. **(8 marks)**
   iii) Tensile strain.
   iv) Young's Modulus.
b) Prove that the formula for Young's modulus, E= $\frac{F.\ L_0}{A.\ \Delta L}$. **(2 marks)**
c) Discuss the importance of selecting appropriate materials in engineering design. Provide two examples. **(4 marks)**

d) A steel wire of original length 2 m and cross-sectional area $5\times10^{-6}\,m^2$ is subjected to a tensile force of 1000 N. If Young's Modulus for steel is 2×10^{11} , calculate.
   i) The stress.
   ii) The strain. **(6 marks)**
   iii) The extension produced in the wire.

Question 4

a) Define static friction and dynamic friction and explain the difference between them. **(3 marks)**
b) State and explain the laws of friction with examples. **(4 marks)**
c) Describe internal and external fluid friction with real-life examples. **(3 marks)**
d) Discuss two problems caused by friction in machinery and how they can be mitigated. **(2 marks)**
e) Discuss at least two methods of minimizing friction in mechanical systems. **(4 marks)**
f) A 50 kg block rests on a horizontal surface. The coefficient of static friction is 0.25, and the coefficient of dynamic friction is 0.2. Calculate:
   i) The limiting friction force.
   ii) The force required to keep the block moving with constant velocity. (Take $g=9.8m/s^2$). **(4 marks)**

Question 5

a) State and explain the torsion equation, clearly defining each term involved. **(6 marks)**
b) Write the expressions for the polar moment of inertia for both solid and hollow shafts and compare them. **(4 marks)**
c) Define the term power transmission in the context of shafts and explain how it relates to torque and angular velocity. **(4 marks)**
d) A steel shaft with a permissible shear stress of 50 MPa has a diameter of 40 mm. Calculate the maximum power it can safely transmit at 1500 rpm. **(6 marks)**