**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**

**FIRST SEMESTER 2023-2024**

**ME F211/ MF F211 MECHANICS OF SOLIDS**

Mid-Semester Examination (Regular) (Closed Book)

**Date: Oct12, 2023** **Duration: 90 Minutes** **Max Marks:60**

***Note:***

1. ***There are total 4 questions***
2. ***Start every question from a fresh page.***

---

Q1 Two blocks **A** and **B**, each having the same mass of **6kg**, are connected by a linkgae as shown in **Fig.Q1**. The structure is at rest. The coefficients of static friction at the contact surfaces are $\mu_A = 0.2$ and $\mu_B = 0.8$ respectively.The weight of the links are negligible and the pins of the links are frictionless. Assume $g = 9.8 m/s^2$. **[10M]**

a. Draw the **free body diagram of block A and block B**.

**b.** Determine the **magnitude of the largest vertical force P** that may be applied to pin C so that block **A** does not slide and block **B** is just about to impend to slide. Also find the **forces in link AC and BC respectively.**

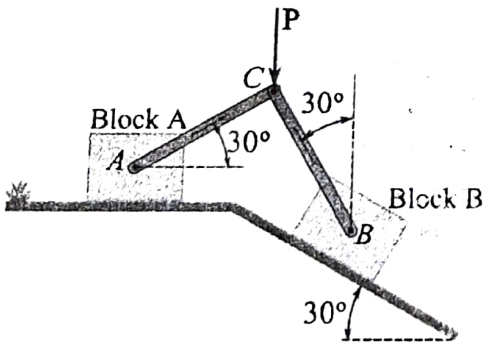


Fig.Q1

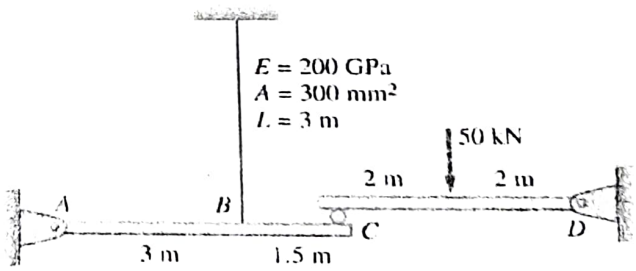


Fig.Q2

Q2 The **rigid bars ABC** and **CD** are supported by pin joint at **A** and **D** and by a steel rod at **B** as shown in **Fig.Q2**. There is a roller support between the bars at **C**. **[15M]**

a. Draw the **free body diagram** of rigid bars **ABC and CD**.

b. Calculate the **support reactions at A, C and D** respectively.

c. Calculate the **tension** in the steel rod.

d. Calculate the **vertical displacement of point C**.

Q3) The compound beam **ABCDE** shown in **FigQ3** consists of two beams **AB** and **BCDE** joined by a hinged connection at B. *The hinge can transmit a shear force but not a bending moment.* A force of **160 kN** acts downward at **D** and a uniform load of intensity **80 kN/m** acts downward on beam **AB**.

***Note: at A and C there are roller supports, whereas at E it is a hinged support***

(i) Calculate support reactions ($R_A$ $R_B$, $R_C$ and $R_E$).

(ii) **Using Singularity Function** method, determine **Shear Force and Bending Moment values** at points **A, B C, D, & E** respectively. Write the answers in the table format and add the discontinuities (if any) at any certain point in the table.

Give values in tabular form

| Point | A | B | C | D | E |
|---|---|---|---|---|---|
| V(k N) | | | | | |
| M(k N-m) | | | | | |

(iii) Draw Shear Force and Bending Moment Diagram of beam **ABCDE** indicating values at salient points.

(iv) Determine magnitude and location of **maximum bending moment**. **[20M]**

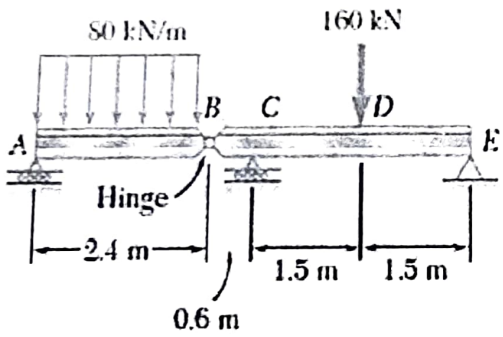


**Fig.Q3**

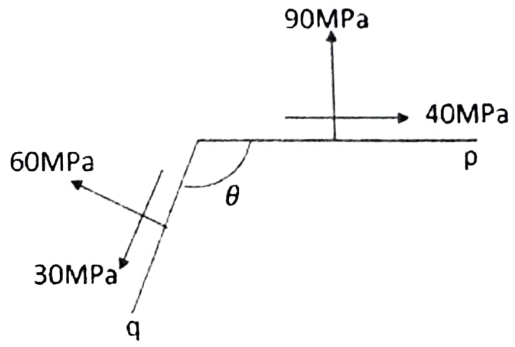


**Fig.Q4**

Q4) A point on a thin plate is subjected to the stresses as shown in **FigQ4**.The stresses on a certain plane '***p***'are **90MPa tensile and 40MPa shear** whereas on another plane '***q***' are **60MPa tensile and 30MPa shear** respectively. **[15M]**

a) Draw the Mohr's circle for the given state of stress at a point.

**b)** Determine the principal planes and the principal stresses with the help of Mohr's circle.

**c)** Determine the angle '$\theta$' between the **plane '*p*'and plane '*q*'**.

BEST OF LUCK