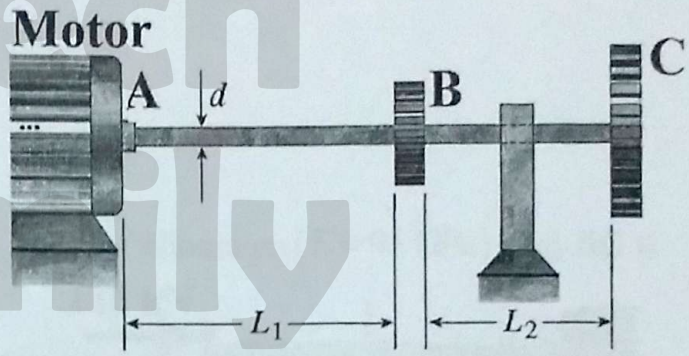
The Jordan University

FACULTY OF ENGINEERING, Mechanical Engineering Department

Mechanics of Materials (I) *0934372* *Midterm Exam (17/4/2014)* *Time: 90 m*

Student Name	Student #	Instructors Name	Section #

Q.1 (8- points) The shaft ABC shown in the figure is driven by a motor that delivers 270 kW at a rotational speed of 32 Hz. The gears at B and C take out 90 kW and 180 kW, respectively. The lengths of the two parts of the shaft are $L_1 = 1.6$ m and $L_2 = 1.1$ m. The shear modulus of elasticity of the shaft is $G = 75$ GPa.



a) If the diameter of the shaft ABC is $d = 45$ mm, find the maximum shear stress in the shaft ABC and angle of twist between points A and C.

b) Determine the required diameter d of the shaft, if the allowable shear stress is 110 MPa, and the allowable angle of twist between points A and C is 5.0°.

Q.2 (3- points) The solid cylindrical rods (1) and (2) are joined together by a rigid flange at B and loaded by **three forces** as shown. The diameter of rod (1) is $d_1 = 24\text{mm}$ and the diameter of rod (2) is $d_2 = 42\text{mm}$.

A) The normal stresses in rods (1) and (2) are:

a) $\sigma_1 = 44.17$ MPa (T) and $\sigma_2 = 132.63$ MPa (C)

b) $\sigma_1 = 176.84$ MPa (T) and $\sigma_2 = 144.36$ MPa (C)

c) $\sigma_1 = 144.36$ MPa (T) and $\sigma_2 = 176.84$ MPa (C)

d) $\sigma_1 = 132.63$ MPa (T) and $\sigma_2 = 44.17$ MPa (C)

e) $\sigma_1 = 176.84$ MPa (T) and $\sigma_2 = 202.10$ MPa (C)

B) The total elongation of the bar ABC if AB is made of aluminum $(E = 95\text{ GPa})$ and BC is made of steel $(E = 205\text{ GPa})$.

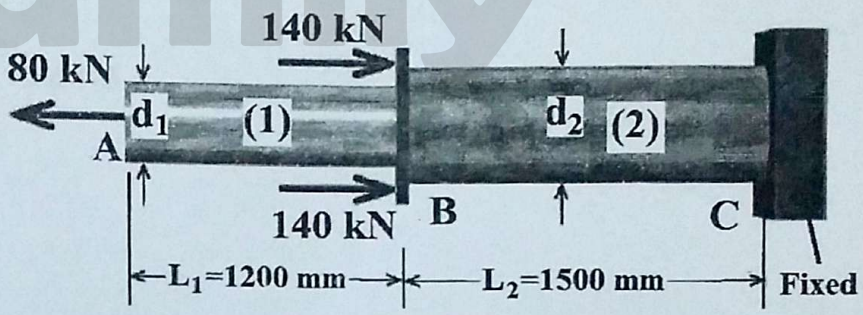
a) 3.290 mm

b) 2.234 mm

c) 0 mm

d) -1.056 mm

e) 1.177 mm



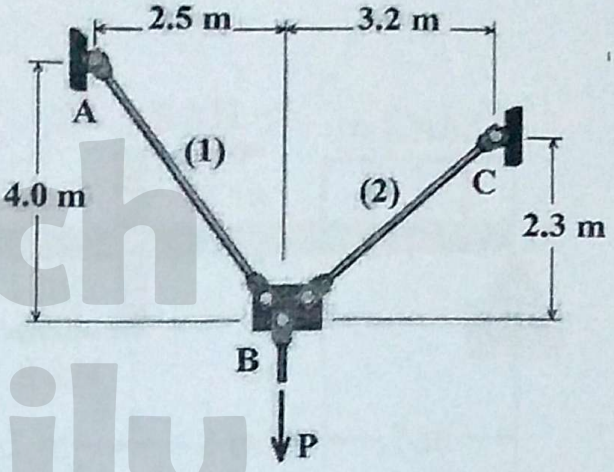
.3 (3- points) The solid cylindrical rods support a load $(P=50\ \text{kN})$ as shown. If the normal stress in each rod must be limited to 130 MPa :

A) The minimum diameter required for rod (1) is:

a) 19.96 mm
b) 14.981 mm
c) 18.96 mm
d) 14.00 mm
e) 9.981 mm

B) The shear stress in the 22 mm diameter bolt at point C (see the connection of the rod at C) is:

a) 17.46 MPa
b) 53.52 MPa
c) 34.93 MPa
d) 69.86 MPa
e) 107.03 MPa



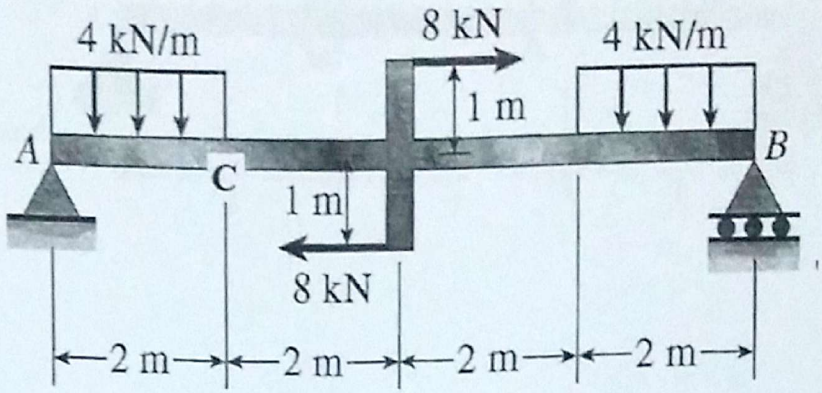
4 (3- points) A simple beam AB is loaded as shown.

A) The internal shear force at Section passes through C is:

a) 5 kN
b) 0 kN
c) 3 kN
d) 4 kN
e) -2 kN

B) The internal moment at Section passes through C is:

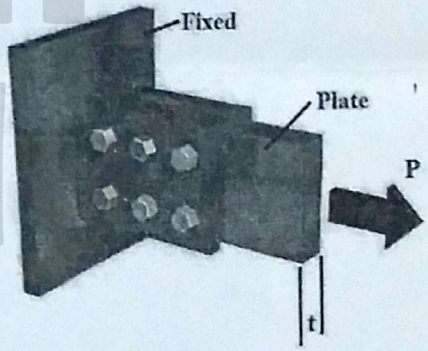
a) 5 kN. m
b) 4 kN. m
c) 0 kN. m
d) 6 kN. m
e) 7 kN. m



Q.5 (3- points) Six bolts are used in the connection, as shown. The ultimate shear strength of the bolts is $\tau_u = 300\text{MPa}$, with a factor of safety (F.S.) 4 with respect to fracture $\left(\tau_{allow} = \frac{\tau_u}{F.S.}\right)$.

A) The minimum allowable diameter to support an applied load $P = 475\text{kN}$ is:

a) 26 mm
b) 37 mm
c) 36 mm
d) 18 mm
e) 23 mm



B) If the thickness of the plate $t = 20\text{mm}$, and the diameter of the bolt $d = 30\text{mm}$. The bearing stress between the plate and the bolts is:

a) 131.94 MPa
b) 252.24 MPa
c) 76.120 MPa
d) 152.24 MPa
e) 65.972 MPa

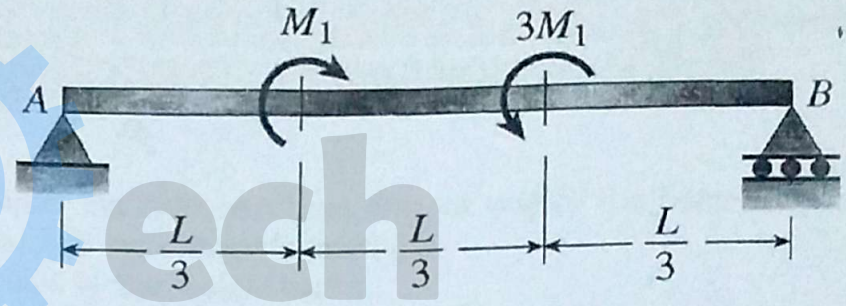
4.6 (3- points) A simple beam AB is loaded as shown.

A) The maximum shear along the beam is:

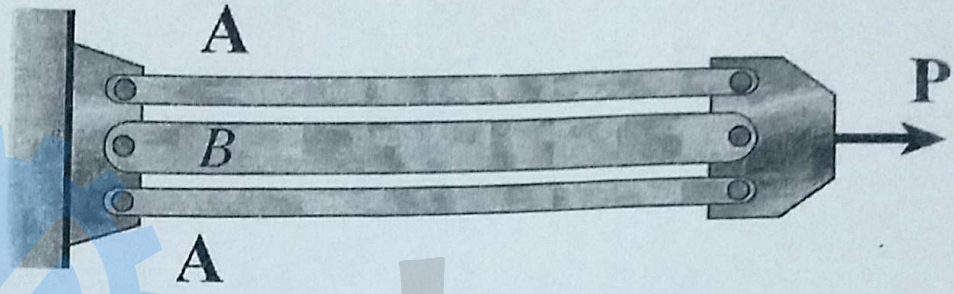
a) M_1/L
b) $2M_1/L$
c) $3M_1/L$
d) $4M_1/3$
e) $5M_1/L$

B) The maximum bending moment along the beam is:

a) $6M_1/3$
b) $3M_1$
c) $5M_1/3$
d) $7M_1/3$
e) $4M_1/3$



Q.7 (9- points) Three prismatic bars, two of material *A* and one of material *B*, transmit a tensile load *P* (see figure). The two outer bars (material *A*) are identical. The cross-sectional area of the middle bar (material *B*) is 50% larger than the cross-sectional area of one of the outer bars. Also, the modulus of elasticity of material *A* is twice that of material *B*.



(a) What fraction of the load *P* is transmitted by the middle bar?

(b) What is the ratio of the stress in the middle bar to the stress in the outer bars?

(c) What is the ratio of the strain in the middle bar to the strain in the outer bars?