Program: BSc. in IPE (4th Semester)

Date: 05 March, 2024
Time: 10:00 to 11:30 AM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANIZATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid-Semester Examination
Course Number: ME 4403
Course Title: Mechanics of Materials

Summer Semester: 2022-2023
Full Marks: 75
Time: 1.5 hours

There are 3 (three) questions. Answer all the questions. The symbols have their usual meanings. Marks of each Question and the corresponding CO and PO are written in the brackets. Assume a reasonable value of any missing data.

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1. a) Define the modulus of elasticity of a material. Describe the stress-strain diagram for a ductile material indicating different points and state the reason for the sudden stress drop in the specific point at the diagram. (10) (CO1) (PO1) K1

   b) The composite bar in Fig. 1 (b) is stress-free before applying axial loads P1 and P2. Calculate the stress in each material if P1= 150 KN, P2 = 90 KN, and the right wall yields 0.80 mm. (15) (CO1) (PO1) P1 K3

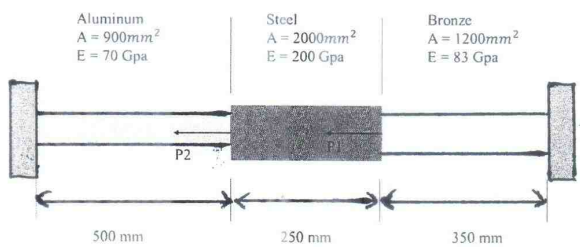

Fig. 1 (b)

2. a) For a simply supported beam of length L (m), under uniformly distributed load w (KN/m), formulate the relation between shear force (Q) and bending moment (M). (7) (CO2) (PO2) P1 K3

   b) Draw shear force and bending moment diagrams for the beam shown in Fig 2. (b) Indicate the numerical values at all important sections. Determine the point of contraflexure. (18) (CO2) (PO2) P1 K3

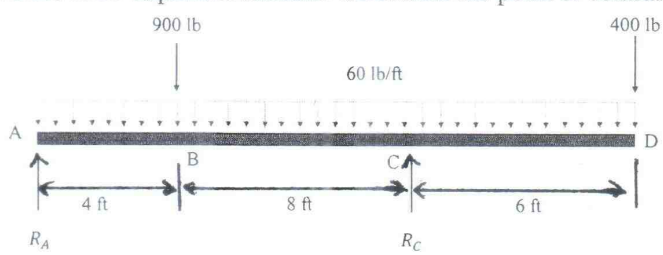

Fig. 2 (b)

3. a) Formulate the relation between the angle of twist (θ) and applied Torque (T) for a cylindrical solid bar of radius R and length L. (10) (CO2) (PO2) P1 K3

b) A shaft composed of segments AC, CD, and DB is fastened to rigid supports and loaded as shown in Fig. 3(b). For bronze, G = 35 GPa; aluminum, G = 28 GPa, and for steel, G = 83 GPa. D = shaft diameter. Determine the maximum shearing stress developed in each segment. (15) (CO2) (PO2) P1 K3

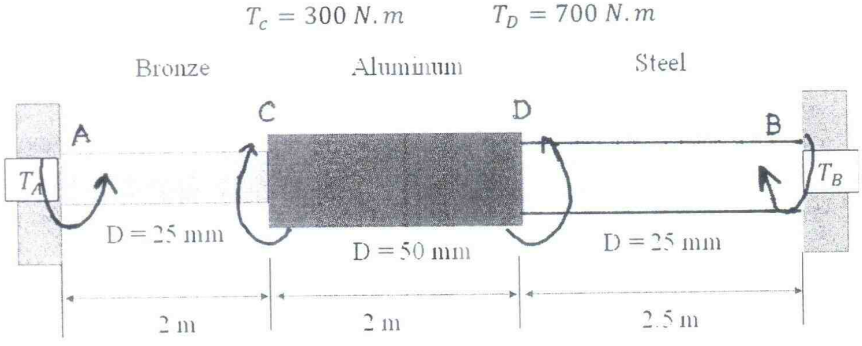

Fig. 3 (b)

$$S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

TABLE B Factors for Computing Central Lines and 3σ Control Limits for $\bar{X}$, s, and R Charts

Observations in Sample, n	CHART FOR AVERAGES			CHART FOR STANDARD DEVIATIONS						CHART FOR RANGES				
	Factors for Control Limits			Factor for Central Line	Factors for Control Limits				Factor for Central Line	Factors for Control Limits				
	A	A_2	A_3	c_4	B_3	B_4	B_5	B_6	d_2	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	0	3.267	0	2.606	1.128	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	0	2.568	0	2.276	1.693	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	0	2.266	0	2.088	2.059	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	0	2.089	0	1.964	2.326	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	0.030	1.970	0.029	1.874	2.534	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	0.118	1.882	0.113	1.806	2.704	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	0.185	1.815	0.179	1.751	2.847	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	0.239	1.761	0.232	1.707	2.970	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	0.284	1.716	0.276	1.669	3.078	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	0.321	1.679	0.313	1.637	3.173	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	0.354	1.646	0.346	1.610	3.258	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	0.382	1.618	0.374	1.585	3.336	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	0.406	1.594	0.399	1.563	3.407	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	0.428	1.572	0.421	1.544	3.472	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	0.448	1.552	0.440	1.526	3.532	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	0.466	1.534	0.458	1.511	3.588	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	0.482	1.518	0.475	1.496	3.640	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	0.497	1.503	0.490	1.483	3.689	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	0.510	1.490	0.504	1.470	3.735	0.729	1.549	5.921	0.415	1.585