ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATIONS
2019/2020 ACADEMIC SESSION

COURSE: MEE 407 – Advanced Mechanics of Materials (3 Units)

CLASS: 400 Level Mechanical Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer Question **One (1)** and any other **FOUR (4)**

HOD'S SIGNATURE

Date: February, 2020

Question 1 (12 MARKS)

(a) The principal objective of mechanics of materials is to determine the stresses, strains, and displacements in structures and their components due to the loads acting on them. True/False
(b) Name the most fundamental concepts in mechanics of materials.
(c) What is axial force?
(d) State one example of prismatic bar in an automobile engine.
(e) The equation $\sigma = P/A$ is valid only if the stress is irregularly distributed over the cross section of the bar. True/False
(f) State two examples of a pressure vessel.
(g) The boundary conditions for a beam depend on how the beam is supported at its ends. True/False
(h) What is a prismatic bar?
(i) What is interface pressure in a composite cylinder?
(j) The mechanics of materials focuses mainly on the more or less approximate solutions of practical problems. True/False
(k) Which method try to provide extra equations when finding the unknown(s) in an indeterminate member? (a) equilibrium method (b) Compatibility method (c) material responses method (d) stress-strain relations method
(l) What is shrink-fit allowance?

Question 2 (12 MARKS)

(a) What is mechanics of materials?
(b) Show that the circumferential stress in cylindrical vessel is equal to twice the longitudinal stress.

Question 3 (12 MARKS)

(a) What is pressure vessel?
(b) Determine the diameters and the negative allowance for a two-layer barrel of inner diameter 120 mm. The maximum pressure the barrel is to withstand is P_{max} = 196000 kPa. The material is steel with E = 196 x 10^5 kPa); σ_{yp} in tension or compression is 588 x 10^3 kPa. The factor of safety is 2.

Question 4 (12 MARKS)

(a) For a beam on an elastic foundation, what will be the value of the spring coefficient, if the width of the beam is a quarter of a unit?

(b) A steel shaft of 24 cm diameter is shrunk inside a bronze cylinder of 60 cm outer diameter. The shrink allowance is 1 part per 1000 (i.e 0.012 cm difference between the radii). Find the circumferential stresses in the bronze cylinder at the inside and outer radii and the stress in the shaft.

$$E_{steel} = 214 \, x \, 10^6 \, kPa$$
$$E_{bronze} = 107 \, x \, 10^6 \, kPa$$
and v =0.3 for both materials

Question 5 (12 MARKS)

An aluminum alloy I-beam (Figure 1) (depth = 100 mm, $Ix = 2.45 \times 10^6$ mm^4, and E = 72.0 KPa) has a length, L = 6.8 m and is supported by seven identical springs (K = 110 N/mm) spaced at distance L = 1.10 m center to center along the beam. A load P = 12.0 kN is applied at the center of the beam over one of the springs. Using an approximate solution method. Determine:

(a) the maximum deflection, maximum bending moment and maximum bending stress of the beam under the load.

(b) the deflection of the first, second and third springs to the right and left of the load. Take C = 50 mm

Question 6 (12 MARKS)

A railroad uses steel rails (E = 200 KPa) with a depth of 184 mm. The distance from the top of the rail to its centroid is 99.1 mm, and the moment of inertia of the rail is 36.9×10^6 mm^4. The rail is supported by ties, ballast, and a road bed that together are assumed to act as an elastic foundation with spring constant k = 14.0 N/mm^2.

(a) Determine the maximum deflection, maximum bending moment, and maximum flexural stress in the rail for a single wheel load of 170 kN.

(b) A particular diesel locomotive has three wheels per bogie equally spaced at 1.70m. Determine
(i) the maximum deflection,
(ii) maximum bending moment, and
(iii) maximum flexural stress in the rail if the load on each wheel is 170 kN.

Question 7 (12 MARKS)

(a) (i) List the six possible types of structure
(ii) What are the similarities and differences between a sieve and a spider web.

(b) Explain the working principles of shells.

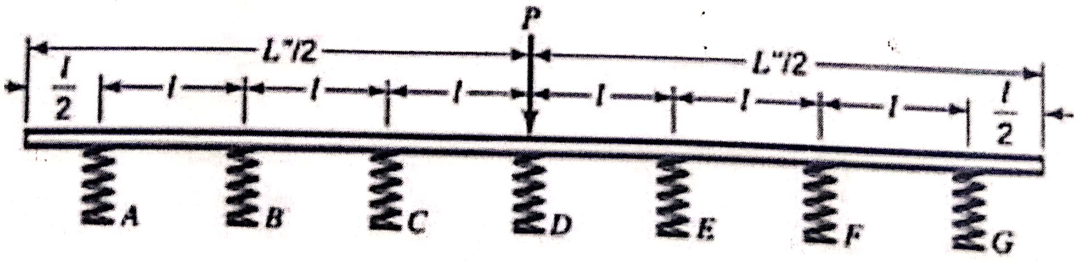

Figure 1: Spring-supported aluminum alloy I-beam

Table 1: Selected values of $A_{\beta z}$, $B_{\beta z}$, $C_{\beta z}$, and $D_{\beta z}$,

βz	$A_{\beta z}$	$B_{\beta z}$	$C_{\beta z}$	$D_{\beta z}$
0	1	0	1	1
0.02	0.9996	0.0196	0.9604	0.9800
0.04	0.9984	0.0384	0.9216	0.9600
0.10	0.9906	0.0903	0.8100	0.9003
0.20	0.9651	0.1627	0.6398	0.8024
0.30	0.9267	0.2189	0.4888	0.7078
0.40	0.8784	0.2610	0.3564	0.6174
0.50	0.8231	0.2908	0.2414	0.5323
0.60	0.7628	0.3099	0.1430	0.4529
0.70	0.6997	0.3199	0.0599	0.3798
$\frac{1}{4}\pi$	0.6448	0.3224	0	0.3224
0.80	0.6353	0.3223	−0.0093	0.3131
0.90	0.5712	0.3185	−0.0658	0.2527
1.00	0.5083	0.3096	−0.1109	0.1987
1.10	0.4476	0.2967	−0.1458	0.1509
1.20	0.3898	0.2807	−0.1716	0.1091
1.30	0.3355	0.2626	−0.1897	0.0729
1.40	0.2849	0.2430	−0.2011	0.0419
1.50	0.2384	0.2226	−0.2068	0.0158
$\frac{1}{2}\pi$	0.2079	0.2079	−0.2079	0
1.60	0.1960	0.2018	−0.2077	−0.0059
1.70	0.1576	0.1812	−0.2046	−0.0236
1.80	0.1234	0.1610	−0.1985	−0.0376
1.90	0.0932	0.1415	−0.1899	−0.0484
2.00	0.0667	0.1230	−0.1793	−0.0563
2.20	0.0244	0.0895	−0.1547	−0.0652
$\frac{3}{4}\pi$	0	0.0671	−0.1342	−0.0671
2.40	−0.0056	0.0613	−0.1282	−0.0669
2.60	−0.0254	0.0383	−0.1020	−0.0637
2.80	−0.0369	0.0204	−0.0777	−0.0573
3.00	−0.0422	0.0071	−0.0563	−0.0493
π	−0.0432	0	−0.0432	−0.0432
3.20	−0.0431	−0.0024	−0.0383	−0.0407
3.40	−0.0408	−0.0085	−0.0238	−0.0323
3.60	−0.0366	−0.0121	−0.0124	−0.0245
3.80	−0.0314	−0.0137	−0.0040	−0.0177
$\frac{5}{4}\pi$	−0.0278	−0.0140	0	−0.0139
4.00	−0.0258	−0.0139	0.0019	−0.0120
$\frac{3}{2}\pi$	−0.0090	−0.0090	0.0090	0
2π	0.0019	0	0.0019	0.0019