L-2/T-1/NAME **Date: 11/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **NAME 219** (Marine Engines and Fuels)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

The symbols have their usual meanings. Assume reasonable value of any data if missing.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Why the cylinder scavenging process is much more critical in a two-stroke engine than in a four-stroke engine? Explain with the necessary diagrams. **(15)**

   (b) In on IC engine, it is essential to open and close the valves precisely to run the engine efficiently. Broadly describe the system which controls the operation of the valves by using the sketch if the whole system along with the views of individual components of the system. **(20)**

2. (a) Why don't we use a high compression ratio in the SI engine? Draw the cross-section of a basic carburetor and illustrate how the full load and the part-load conditions are achieved by the throttle valve mechanism in an engine. **(15)**

   (b) Write short notes on the followings- **(20)**

   (i) Pre-flame combustion period
   (ii) Turbo lag
   (iii) Compression ring and oil ring
   (iv) Over square engine and under square engine

3. (a) How electricity is produced in a hydro-electric power plant and why it is considered a source of renewable energy? Briefly explain which component distinguishes the liquid-dominant geothermal power plant from the vapour-dominant system. **(15)**

   (b) Differentiate between viscosity index and viscosity grading in an elaborate manner. Classify the types of lubricating oil reservation in a compression ignition engine using neat sketches. **(20)**

4. A three-liter SI V6 square engine is operating on a four-stroke cycle at 3600 RPM. At this speed, air enters the cylinders at 85 kPa and 60°C. A dynamometer connected to the engine is giving a brake output torque reading of 205 N-m at 3600 RPM. The engine is running with an air-fuel ratio of 15, fuel heating value of 44000 kJ/kg, compression ratio of 9.5, combustion efficiency of 97% and mechanical efficiency of 85%. Calculate- **(35)**

   (i) Clearance volume of each cylinder
   (ii) Indicated power (in hp unit)
   (iii) Friction mean effective pressure (in psi unit)
   (iv) Brake work per unit mass of gas in the cylinder (in BTU/lbm unit)
   (v) Indicated thermal efficiency
   (vi) Volumetric efficiency
   (vii) Brake specific fuel consumption (in lbm/hp-hr unit).

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Define Calculated Carbon Index. A heavy fuel oil at 15°C has a density of 991 kg/m^3 and a viscosity of 2.9 CST. Can this fuel be used in a ship or not? Justify your answer. **(13)**

(b) Describe the 4 major problems related to the use of the Heavy Fuel Oil in marine engines. Despite of having these problems why HFO is used in marine engines as primary fuel? **(15)**

(c) What is Governor? Why it is more important in CI engine rather than SI engine? **(7)**

6. (a) Define Octane number and cetane number. What will happen if we use high octane number fuel than specified? **(7)**

(b) An 8 cylinder 2-stroke C.I. engine develops 220 KW power at 1200 rpm with brake specific fuel consumption of 0.273 kg/KWh. The diameter of the single hole injector nozzle is 0.8 mm. The period of injection is 30° of crank angle. Specific gravity of fuel = 0.85 and the orifice discharge co-efficient = 0.9. Determine the pressure difference required to be created by nozzle for injecting the fuel into the cylinder. **(18)**

(c) Describe the working principle of the 'Energy Cell' combustion chamber in C.I. engine with schematic diagram. **(10)**

7. (a) Describe the 7 major differences between the Open and Divided combustion chambers. **(15)**

(b) Explain the functions of all the components used in a typical water-cooling system elaborately and draw a schematic diagram of that system. **(20)**

8. (a) Derive the expression for the maximum net-work output of the Brayton cycle with Reheater, if the inlet temperatures of the high-pressure and low-pressure turbine are equal, and the ratio of the maximum and minimum temperature remains constant. **(20)**

(b) Draw a schematic diagram of a Brayton cycle with the heat exchanger, reheater and intercooler. Also draw the T-S diagram. **(15)**

L-2/T-1/NAME **Date: 30/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **NAME 251** (Mechanics of Structures)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) The composite bar as shown in Fig. for Q. No. 1(a) is stress-free before the axial loads P_1 and P_2 are applied. Assuming that the walls are rigid, calculate the stress in each material if $P_1 = 150\ kN$, $P_2 = 90\ kN$ and the right wall yields 0.80 *mm*. **(15)**

(b) A homogeneous rigid block weighing 12 *kips* that is supported by three symmetrically placed rods as shown in Fig. for Q. No. 1(b). The lower ends of the rods were at the same level before the block was attached. Determine the stress sin each rod after the block is attached and the temperature of all bars increases by 100°*F*. Use the following data: **(10)**

	A ($in.^2$)	E (psi)	a (/°F)
Each steel rod	0.75	29×10^6	6.5×10^{-6}
Bronze rod	1.50	12×10^6	10.0×10^{-6}

(c) The 4-*mm*-diameter cable *BC* is made of a steel with $E = 200\ GPa$. Knowing that the maximum stress in the cable must not exceed 190 *MPa* and that the elongation of the cable must not exceed 6 *mm*, find the maximum load *P* that can be applied as shown in Fig. for Q. No. 1(c). **(10)**

2. (a) Determine by the double-integration method, the maximum deflection for a simply-supported beam of *L ft.* long, loaded uniformly with *w lb/ft.* (Assume, *E* and *I* constant) **(15)**

(b) For the uniform beam *AB* as shown in Fig. for Q. No. 2(b), (i) determine the reaction at *A* (ii) derive the equation of the elastic curve, and (iii) determine the slope at *A*. (None that the beam is statically indeterminate to the first degree) **(20)**

3. (a) Plot the shear-force and bending-moment diagrams for the beam loaded as shown in Fig. for Q. No. 3(a). State the maximum magnitudes of shear force and bending moment of the beam. **(20)**

(b) A 2 *m* long pin-ended column of square cross section is to be made of wood. Assuming $E = 13\ GPa$, $\sigma_{allow} = 12\ MPa$, and using a factor of safety of 2.5 in computing Euler's critical load for buckling, determine the size of the cross section if the column is to safely support a 100 *kN* load. **(15)**

Contd P/2

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4. (a) A 5-m-long, simply supported steel beam *AD* is to carry the distributed and concentrated loads as shown in Fig. for Q. No. 4(a). Knowing that the allowable normal stress for the grade of steel to be used is 160 *MPa*, select the wide-flange shape that should be used. **(20)**

(b) A beam with cross-section as shown in Fig. for Q. No. 4(b) is loaded in such a way that the maximum moments are $+1.0P$ *lb. ft* and $-1.5P$ *lb. ft*, where *P* is the applied load in pounds. Determine the maximum safe value of *P* if the working stresses are 4 *ksi* in tension and 10 *ksi* in compression. **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume reasonable value for missing data if any.

5. (a) Derive the relationship between the followings: **(10)**
   (i) Engineering stress and True stress
   (ii) Engineering strain and True strain

(b) Distinguish between the followings: **(10)**
   (i) Modulus of toughness and Modulus of resilience
   (ii) Brittle material and ductile material.

(c) The state of plane stress at a point is represented by the stress element as shown in Fig. for Q. No. 5(c). Determine the stresses acting on an element oriented 30° clockwise with respect to the original element. **(15)**

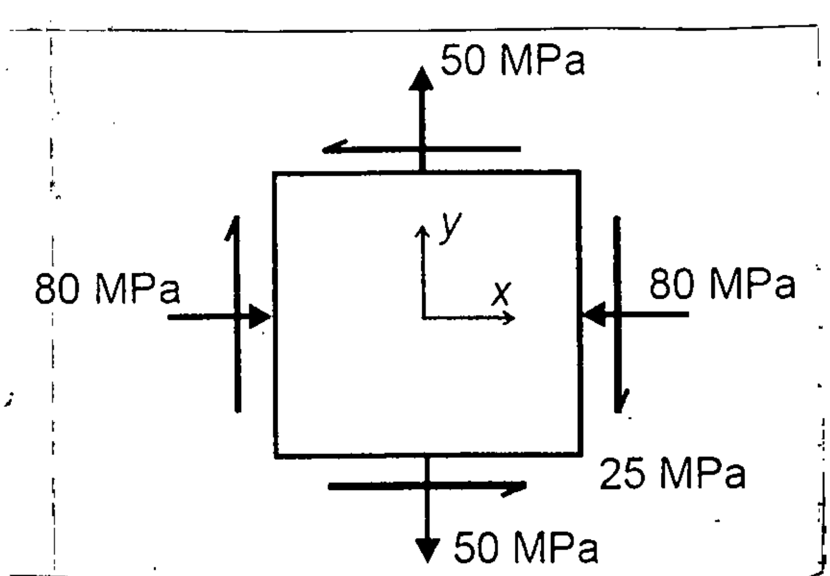

Fig. for Q. No. 5(c)

Contd P/3

6. (a) With necessary assumptions derive an expression for angle of twist of a circular solid shaft. **(10)**

(b) Knowing that each of the shaft AB, BC and CD consist of solid circular rods as shown in Fig. for Q. No. 6(b), determine (i) the shaft in which the maximum shearing stress occurs, (ii) the magnitude of that stress. **(10)**

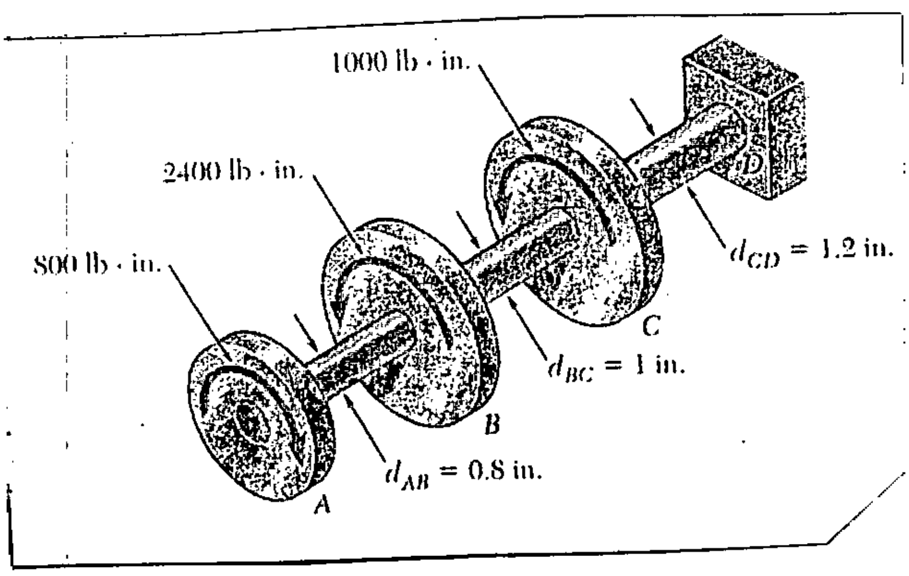

Fig. for Q. No. 6(b)

(c) A 2.50 m long steel shaft of 30 mm diameter rotates at a frequency of 30 Hz. Determine the maximum power that the shaft can transmit, knowing that G = 77.2 GPa, that the allowable shearing stress is 50 MPa, and that the angle of twist must not exceed 7.5°. **(15)**

7. (a) A beam ABCD is supported by a roller at A and a hinge at D. It is subjected to the loads as shown in Fig. for Q. No. 7(a), which act the ends of the vertical members BE and CF. These vertical members are rigidly attached to the beam at B and C. Compute the support reactions. **(15)**

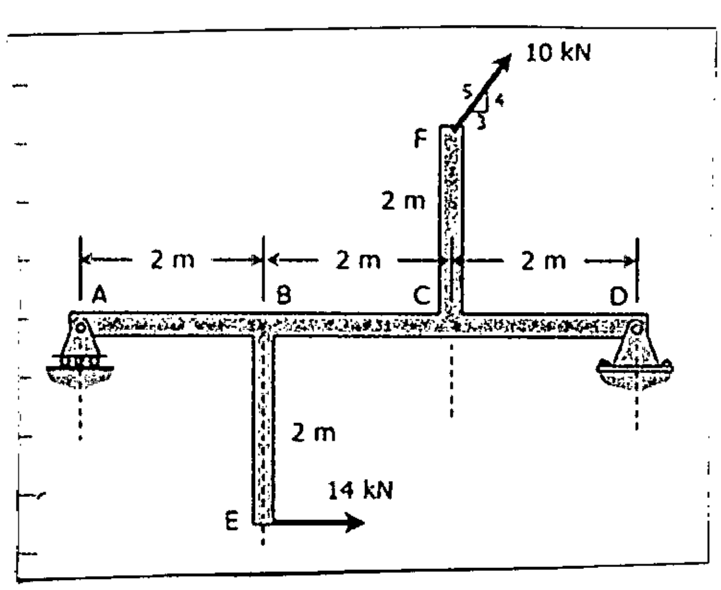

Fig. for Q. No. 7(a)

Contd P/4

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Contd.... for Q. No. 7

(b) The bridge shown in Fig. for Q. No. 7(b) consists of two end sections, each weighing 20 tons with center of gravity at G, hinged to a uniform center span weighing 12 tons. Compute the reactions at A, B, E and F. **(15)**

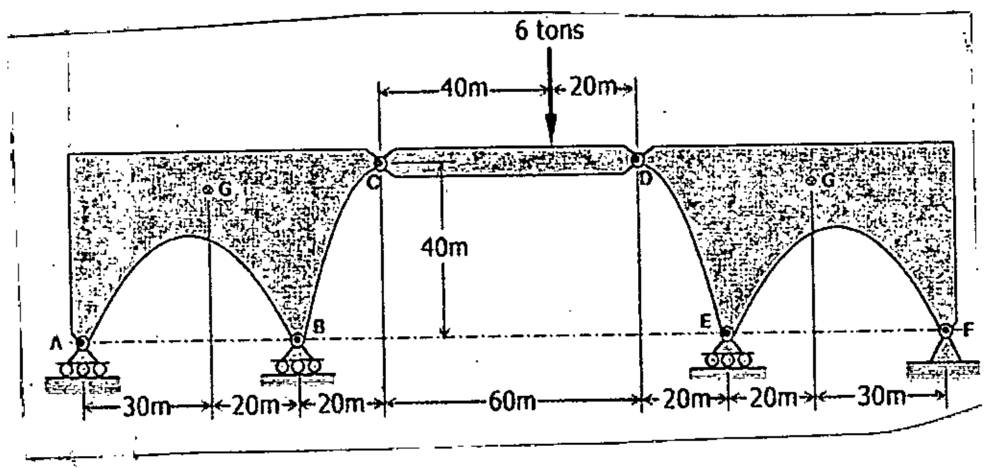

Fig. for Q. No. 7(b)

(c) Explain buckling and critical buckling stress. **(5)**

8. (a) What would be the moment of inertia about x-axis and y-axis of the shape as sown in Fig. for Q. No. 8(a)? **(15)**

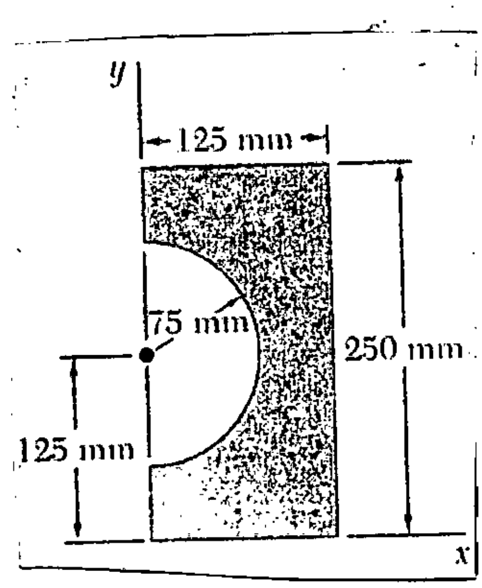

Fig. for Q. No. 8(a)

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Contd.... for Q. No. 8

(b) Determine the forces in the members CD, CE, DF, EF and DE of the truss as shown in Fig. for Q. No. 8(b). **(15)**

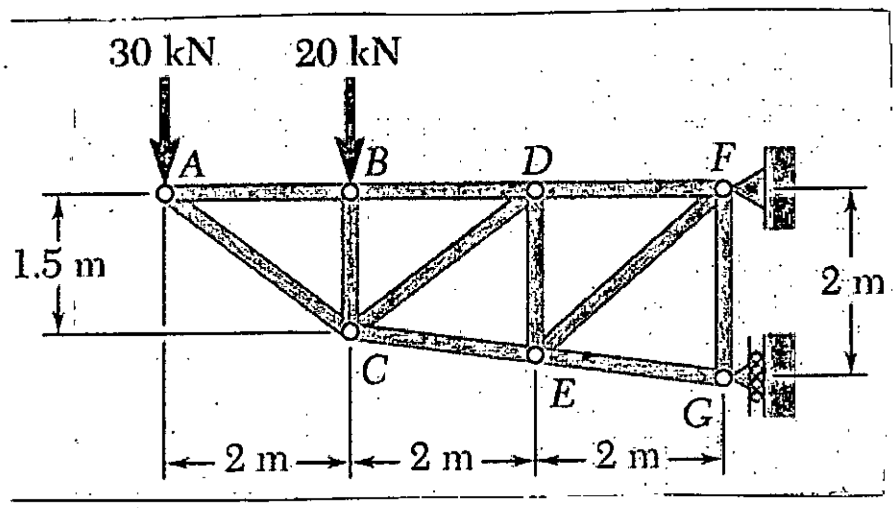


Fig. for Q. No. 8(b)

(c) Define principal stress and principal plane. **(5)**

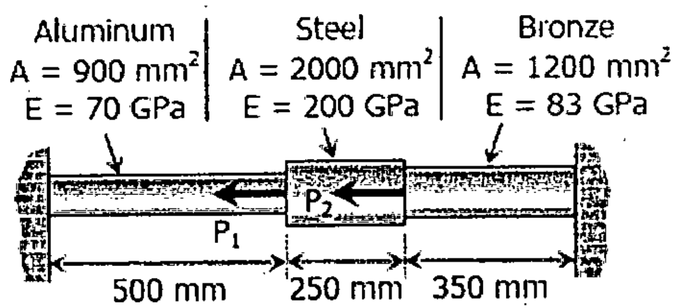


Fig. for Q. No. 1(a)

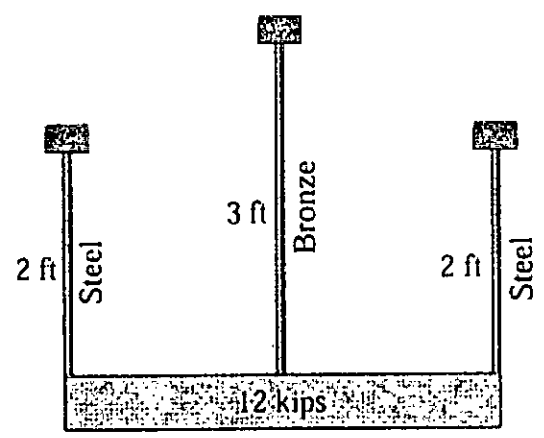


Fig. for Q. No. 1(b)

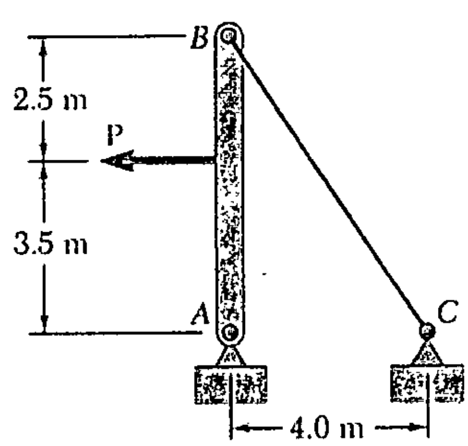


Fig. for Q. No. 1(c)

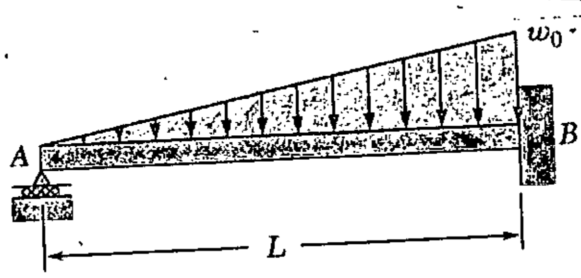


Fig. for Q. No. 2(b)

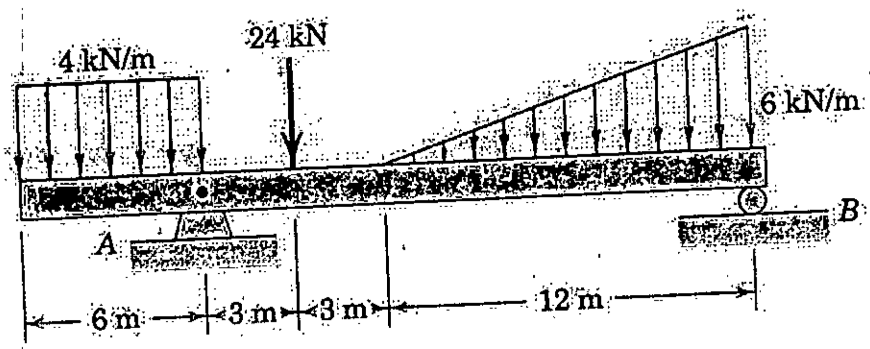


Fig. for Q. No. 3(a)

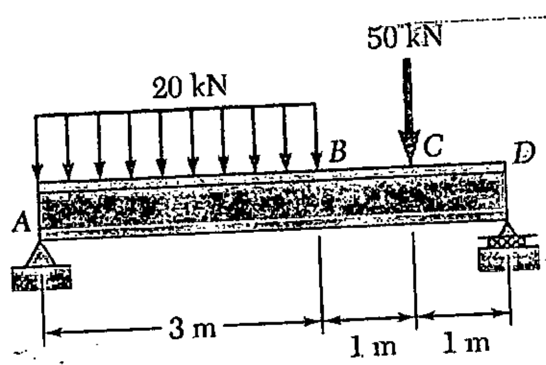
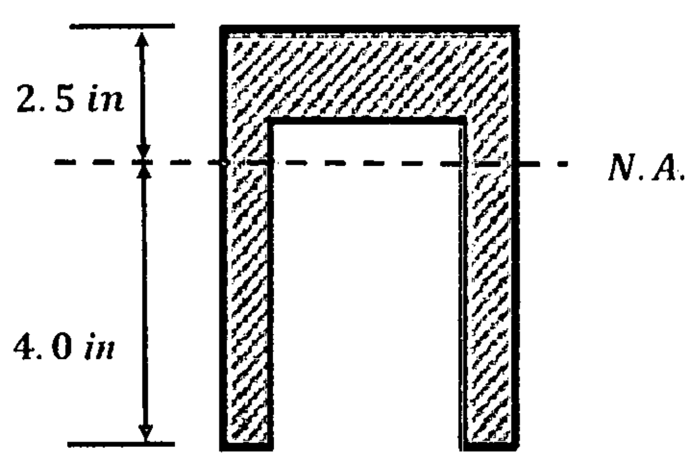


Fig. for Q. No. 4(a)



$I_{NA} = 192\ in^4$

Fig. for Q. No. 4(b)

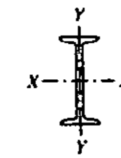


TABLE B-2 *Properties of Wide-Flange Sections (W-Shapes): SI Units*

Designation	Mass (kg/m)	Area (mm²)	Depth (mm)	Flange Width (mm)	Flange Thickness (mm)	Web thickness (mm)	Axis X-X I (10^6 mm⁴)	Axis X-X $S = I/c$ (10^3 mm³)	Axis X-X $r = \sqrt{I/A}$ (mm)	Axis Y-Y I (10^6 mm⁴)	Axis Y-Y $S = I/c$ (10^3 mm³)	Axis Y-Y $r = \sqrt{I/A}$ (mm)
W920 × 449	449	57 300	947	424	42.7	24.0	8 780	18 500	391	541	2 560	97.0
× 420	420	53 500	942	422	39.9	22.5	8 160	17 200	391	499	2 360	96.5
× 390	390	49 700	937	422	36.6	21.3	7 450	15 900	389	454	2 160	95.5
× 368	368	46 800	932	419	34.3	20.3	6 950	15 000	386	420	2 020	95.0
× 344	344	43 900	927	419	32.0	19.3	6 490	14 000	384	391	1 870	94.2
× 381	381	48 600	951	310	43.9	24.4	6 990	14 700	378	220	1 420	67.3
× 345	345	43 900	943	307	39.9	22.1	6 240	13 300	376	195	1 270	66.5
× 313	313	39 900	932	310	34.5	21.1	5 490	11 800	371	171	1 110	65.5
× 289	289	36 800	927	307	32.0	19.4	5 040	10 900	371	156	1 010	65.0
× 271	271	34 600	922	307	30.0	18.4	4 700	10 200	368	144	944	64.8
× 253	253	32 300	919	305	27.9	17.3	4 370	9 520	368	133	872	64.3
× 238	238	30 300	914	305	25.9	16.5	4 060	8 880	366	123	805	63.5
× 223	223	28 500	912	305	23.9	15.9	3 760	8 260	363	112	739	62.7
× 201	201	25 600	904	305	20.1	15.2	3 250	7 190	356	93.7	618	60.5
W840 × 359	359	45 800	869	404	35.6	21.1	5 910	13 600	358	388	1 930	91.9
× 329	329	42 100	861	401	32.5	19.7	5 370	12 400	358	350	1 740	91.2
× 299	299	38 200	856	399	29.2	18.2	4 830	11 200	356	312	1 560	90.4
× 226	226	28 900	851	295	26.9	16.1	3 400	7 980	343	114	773	62.7
× 210	210	26 800	846	292	24.4	15.4	3 100	7 340	340	102	700	61.7
× 193	193	24 700	841	292	21.7	14.7	2 790	6 650	335	90.7	621	60.7
× 176	176	22 400	836	292	18.8	14.0	2 460	5 880	330	77.8	534	58.9
W760 × 314	314	40 100	785	384	33.5	19.7	4 290	10 900	328	315	1 640	88.6
× 284	284	36 300	780	381	30.2	18.0	3 830	9 830	325	280	1 470	87.9
× 257	257	32 900	772	381	27.2	16.6	3 430	8 870	323	249	1 310	86.9
× 220	220	28 100	780	267	30.0	16.5	2 780	7 140	315	94.5	710	57.9
× 196	196	25 100	770	267	25.4	15.6	2 400	6 230	310	81.6	610	57.2
× 185	185	23 500	767	267	23.6	14.9	2 230	5 820	307	75.3	564	56.6
× 173	173	22 100	762	267	21.6	14.4	2 050	5 360	305	68.3	513	55.6
× 161	161	20 500	757	267	19.3	13.8	1 860	4 900	302	60.8	457	54.6
× 147	147	18 800	754	267	17.0	13.2	1 660	4 410	297	53.3	401	53.3

W690 × 265	265	33 900	706	358	30.2	18.4	2 920	8 280	295	231	1 290	82.6
× 240	240	30 700	701	356	27.4	16.8	2 630	7 510	292	207	1 160	82.0
× 217	217	27 800	696	356	24.8	15.4	2 360	6 780	292	184	1 040	81.3
× 192	192	24 400	701	254	27.9	15.5	1 980	5 650	284	76.6	603	56.1
× 170	170	21 600	693	257	23.6	14.5	1 700	4 900	279	66.2	516	55.4
× 152	152	19 400	688	254	21.1	13.1	1 510	4 380	279	57.9	456	54.6
× 140	140	17 900	683	254	18.9	12.4	1 360	3 980	277	51.6	406	53.8
× 125	125	16 000	678	254	16.3	11.7	1 190	3 490	272	44.1	347	52.6
W610 × 241	241	30 800	635	330	31.0	17.9	2 150	6 780	264	184	1 120	77.5
× 217	217	27 700	627	328	27.7	16.5	1 910	6 080	262	163	991	76.5
× 195	195	24 800	622	328	24.4	15.4	1 670	5 390	259	142	869	75.4
× 174	174	22 200	617	325	21.6	14.0	1 470	4 770	257	124	762	74.7
× 155	155	19 700	612	325	19.1	12.7	1 290	4 230	257	108	667	73.9
× 153	153	19 500	622	229	24.9	14.0	1 250	4 010	254	49.5	434	50.5
× 140	140	17 900	617	230	22.2	13.1	1 120	3 640	251	45.4	393	50.3
× 125	125	15 900	612	229	19.6	11.9	986	3 210	249	39.3	342	49.5
× 113	113	14 500	607	228	17.3	11.2	874	2 880	246	34.3	302	48.8
× 101	101	13 000	602	228	14.9	10.5	762	2 520	243	29.3	257	47.5
× 92	92.0	11 700	602	179	15.0	10.9	645	2 150	234	14.4	161	35.1
× 82	82.0	10 500	599	178	12.8	10.0	562	1 870	231	12.1	136	34.0
W530 × 219	219	27 900	561	318	29.2	18.3	1 510	5 390	233	157	985	74.9
× 196	196	25 000	554	315	26.4	16.5	1 340	4 830	232	139	877	74.4
× 182	182	23 200	551	315	24.4	15.2	1 230	4 470	231	127	806	74.2
× 165	165	21 100	546	312	22.2	14.0	1 110	4 080	230	114	729	73.7
× 150	150	19 200	544	312	20.3	12.7	1 010	3 720	229	103	660	73.4
× 138	138	17 600	549	214	23.6	14.7	862	3 150	221	38.7	362	46.7
× 123	123	15 700	544	212	21.2	13.1	762	2 800	220	33.9	320	46.5
× 109	109	13 900	538	211	18.8	11.6	666	2 470	219	29.4	279	46.0
× 101	101	12 900	536	210	17.4	10.9	616	2 290	218	26.9	257	45.7
× 92	92.0	11 800	533	209	15.6	10.2	554	2 080	217	23.9	229	45.0
× 82	82.0	10 500	528	209	13.3	9.53	475	1 800	213	20.1	193	43.9
× 72	72.0	9 100	523	207	10.9	8.89	399	1 520	209	16.1	156	42.2
× 85	85.0	10 800	536	167	16.5	10.3	487	1 820	212	12.7	153	34.3
× 74	74.0	9 480	528	166	13.6	9.65	410	1 550	208	10.4	125	33.0
× 66	66.0	8 390	526	165	11.4	8.89	351	1 340	205	8.62	104	32.0

(continues)

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TABLE B-2 *Properties of Wide-Flange Sections (W-Shapes): SI Units (continued)*

Designation	Mass (kg/m)	Area (mm²)	Depth (mm)	Flange Width (mm)	Flange Thickness (mm)	Web thickness (mm)	Axis X-X I (10^6 mm⁴)	Axis X-X $S = I/c$ (10^3 mm³)	Axis X-X $r = \sqrt{I/A}$ (mm)	Axis Y-Y I (10^6 mm⁴)	Axis Y-Y $S = I/c$ (10^3 mm³)	Axis Y-Y $r = \sqrt{I/A}$ (mm)
W460 × 177	177	22 600	483	287	26.9	16.6	912	3 790	201	105	736	68.3
× 158	158	20 100	475	284	23.9	15.0	795	3 340	199	91.6	646	67.6
× 144	144	18 400	472	282	22.1	13.6	728	3 080	199	83.7	592	67.3
× 128	128	16 300	467	282	19.6	12.2	637	2 720	197	72.8	518	66.8
× 113	113	14 400	462	279	17.3	10.8	554	2 390	196	63.3	452	66.3
× 106	106	13 400	470	194	20.6	12.6	487	2 080	191	25.1	259	43.2
× 97	97.0	12 300	467	193	19.1	11.4	445	1 920	190	22.8	236	42.9
× 89	89.0	11 400	462	192	17.7	10.5	410	1 770	190	20.9	218	42.7
× 82	82.0	10 500	460	191	16.0	9.91	370	1 610	188	18.7	195	42.4
× 74	74.0	9 480	457	191	14.5	9.02	333	1 460	187	16.7	175	41.9
× 68	68.0	8 710	460	154	15.4	9.14	296	1 290	184	9.37	122	32.8
× 60	60.0	7 610	455	153	13.3	8.00	255	1 120	183	7.95	104	32.3
× 52	52.0	6 650	450	152	10.8	7.62	212	944	179	6.37	83.9	31.0
W410 × 149	149	19 000	432	264	25.0	14.9	620	2 870	180	77.4	585	63.8
× 132	132	16 900	427	264	22.2	13.3	541	2 540	179	67.8	515	63.2
× 114	114	14 600	419	262	19.3	11.6	462	2 200	178	57.4	441	62.7
× 100	100	12 700	414	259	16.9	10.0	397	1 920	177	49.5	380	62.5
× 85	85.0	10 800	417	181	18.2	10.9	316	1 510	171	17.9	198	40.6
× 75	75.0	9 480	414	180	16.0	9.65	274	1 330	170	15.5	172	40.4
× 67	67.0	8 580	409	179	14.4	8.76	244	1 190	169	13.7	153	39.9
× 60	60.0	7 610	406	178	12.8	7.75	216	1 060	168	12.0	135	39.9
× 53	53.0	6 840	404	178	10.9	7.49	186	926	165	10.2	115	38.6
× 46.1	46.1	5 890	404	140	11.2	6.99	156	773	163	5.16	73.6	29.7
× 38.8	38.8	4 950	399	140	8.76	6.35	125	629	159	3.99	57.2	28.4
W360 × 1086	1 090	139 000	569	455	125	78.0	5 950	21 000	208	1 960	8 640	119
× 990	990	126 000	549	450	115	71.9	5 160	18 800	203	1 740	7 730	117
× 900	900	115 000	531	442	106	66.0	4 500	17 000	198	1 530	6 930	116
× 818	818	105 000	513	437	97.0	60.5	3 930	15 300	194	1 350	6 190	114
× 744	744	94 800	498	432	88.9	55.6	3 420	13 700	190	1 200	5 560	113
× 677	677	86 500	483	427	81.5	51.3	2 990	12 400	186	1 070	4 980	111
× 634	634	80 600	475	424	77.2	47.8	2 750	11 600	184	982	4 640	110
× 592	592	75 500	465	422	72.4	45.0	2 500	10 700	182	903	4 290	109
× 551	551	70 300	455	419	67.6	42.2	2 260	9 950	180	828	3 950	108
× 509	509	65 200	445	417	62.7	39.1	2 040	9 140	177	753	3 620	108
× 463	463	59 000	434	411	57.4	35.8	1 800	8 290	175	670	3 260	107
× 421	421	53 700	424	409	52.6	32.8	1 600	7 520	172	599	2 930	106
× 382	382	48 800	417	406	48.0	30.0	1 420	6 800	170	537	2 640	105
× 347	347	44 200	406	404	43.7	27.2	1 250	6 150	168	479	2 380	104
× 314	314	40 000	399	401	39.6	24.9	1 110	5 540	166	429	2 130	103
× 287	287	36 600	394	399	36.6	22.6	999	5 080	165	388	1 950	103

W360 × 262	262	33 400	386	399	33.3	21.1	891	4 600	163	349	1 750	102
× 237	237	30 100	381	396	30.2	18.9	791	4 160	162	311	1 580	102
× 216	216	27 500	376	394	27.7	17.3	712	3 800	161	282	1 430	101
× 196	196	25 000	373	373	26.2	16.4	637	3 420	160	228	1 220	95.5
× 179	179	22 800	368	373	23.9	15.0	574	3 110	158	206	1 110	95.0
× 162	162	20 600	363	371	21.8	13.3	516	2 830	158	186	1 000	94.7
× 147	147	18 800	361	371	19.8	12.3	462	2 570	157	167	905	94.2
× 134	134	17 100	356	368	18.0	11.2	416	2 340	156	151	818	94.0
× 122	122	15 500	363	257	21.7	13.0	367	2 020	154	61.6	480	63.0
× 110	110	14 100	361	257	19.9	11.4	331	1 840	153	55.8	436	63.0
× 101	101	12 900	356	254	18.3	10.5	301	1 690	153	50.4	397	62.5
× 91	91.0	11 500	353	254	16.4	9.53	266	1 510	152	44.5	352	62.2
× 79	79.0	10 100	353	205	16.8	9.40	225	1 270	150	24.0	234	48.8
× 72	72.0	9 100	351	204	15.1	8.64	201	1 150	149	21.4	210	48.5
× 64	64.0	8 130	348	203	13.5	7.75	178	1 030	148	18.8	185	48.0
× 57.8	57.8	7 230	358	172	13.1	7.87	160	895	149	11.1	129	39.4
× 51	51.0	6 450	356	171	11.6	7.24	142	796	148	9.70	113	38.9
× 44	44.0	5 710	351	171	9.78	6.86	121	688	146	8.16	95.4	37.8
× 39	39.0	4 960	353	128	10.7	6.48	102	578	144	3.71	58.2	27.4
× 32.9	32.9	4 190	348	127	8.51	5.84	82.8	475	141	2.91	45.9	26.4
W310 × 500	500	63 700	427	340	75.2	45.2	1 690	7 910	163	495	2 900	88.1
× 454	454	57 800	414	335	68.8	41.4	1 480	7 130	160	437	2 610	86.9
× 415	415	52 800	404	333	62.7	38.9	1 290	6 440	156	390	2 340	85.9
× 375	375	47 700	391	330	57.2	35.6	1 130	5 780	154	345	2 080	84.8
× 342	342	43 700	384	328	52.6	32.8	1 010	5 260	152	309	1 880	84.1
× 313	313	39 900	373	325	48.3	30.0	891	4 790	150	276	1 700	83.3
× 283	283	36 000	366	323	44.2	26.9	787	4 310	148	245	1 520	82.6
× 253	253	32 300	356	320	39.6	24.4	687	3 850	146	215	1 350	81.8
× 226	226	28 800	348	318	35.6	22.1	595	3 420	144	189	1 190	81.0
× 202	202	25 700	340	315	31.8	20.1	516	3 050	142	166	1 050	80.3
× 179	179	22 800	333	312	28.2	18.0	445	2 670	140	144	918	79.5
× 158	158	20 100	328	310	25.1	15.5	388	2 380	139	125	808	79.0
× 143	143	18 200	323	310	22.9	14.0	347	2 150	138	112	728	78.5
× 129	129	16 500	318	307	20.6	13.1	308	1 930	137	100	651	78.0
× 117	117	15 000	315	307	18.7	11.9	276	1 750	136	89.9	587	77.5
× 107	107	13 600	312	305	17.0	10.9	248	1 600	135	81.2	531	77.2
× 97	97.0	12 300	307	305	15.4	9.91	222	1 440	134	72.4	477	76.7
× 86	86.0	11 000	310	254	16.3	9.14	198	1 280	134	44.5	351	63.8
× 79	79.0	10 100	307	254	14.6	8.76	177	1 160	133	39.9	315	63.0
× 74	74.0	9 420	310	205	16.3	9.40	163	1 050	132	23.4	228	49.8
× 67	67.0	8 450	307	204	14.6	8.51	145	946	131	20.8	203	49.5

(continues)

TABLE B-2 *Properties of Wide-Flange Sections (W-Shapes): SI Units (continued)*

Designation	Mass (kg/m)	Area (mm²)	Depth (mm)	Flange Width (mm)	Flange Thickness (mm)	Web thickness (mm)	Axis X-X I (10^6 mm⁴)	Axis X-X $S = I/c$ (10^3 mm³)	Axis X-X $r = \sqrt{I/A}$ (mm)	Axis Y-Y I (10^6 mm⁴)	Axis Y-Y $S = I/c$ (10^3 mm³)	Axis Y-Y $r = \sqrt{I/A}$ (mm)
W310 × 60	60.0	7 550	302	203	13.1	7.49	128	844	130	18.4	180	49.3
× 52	52.0	6 650	318	167	13.2	7.62	119	747	133	10.2	122	39.1
× 44.5	44.5	5 670	312	166	11.2	6.60	99.1	633	132	8.45	102	38.6
× 38.7	38.7	4 940	310	165	9.65	5.84	84.9	547	131	7.20	87.5	38.4
× 32.7	32.7	4 180	312	102	10.8	6.60	64.9	416	125	1.94	37.9	21.5
× 28.3	28.3	3 590	310	102	8.89	5.97	54.1	349	122	1.57	30.8	20.9
× 23.8	23.8	3 040	305	101	6.73	5.59	42.9	280	119	1.17	23.1	19.6
× 21	21.0	2 680	302	101	5.72	5.08	36.9	244	117	0.982	19.5	19.1
W250 × 167	167	21 200	290	264	31.8	19.2	298	2 060	118	98.2	742	68.1
× 149	149	19 000	282	262	28.4	17.3	259	1 840	117	86.2	655	67.3
× 131	131	16 700	274	262	25.1	15.4	222	1 610	115	74.5	570	66.8
× 115	115	14 600	269	259	22.1	13.5	189	1 410	114	64.1	493	66.0
× 101	101	12 900	264	257	19.6	11.9	164	1 240	113	55.8	433	65.8
× 89	89.0	11 400	259	257	17.3	10.7	142	1 090	112	48.3	377	65.3
× 80	80.0	10 200	257	254	15.6	9.40	126	983	111	42.9	338	65.0
× 73	73.0	9 290	254	254	14.2	8.64	113	895	110	38.9	306	64.5
× 67	67.0	8 580	257	204	15.7	8.89	103	805	110	22.2	218	51.1
× 58	58.0	7 420	252	203	13.5	8.00	87.0	690	108	18.7	185	50.3
× 49.1	49.1	6 260	247	202	11.0	7.37	71.2	574	106	15.2	151	49.3
× 44.8	44.8	5 700	267	148	13.0	7.62	70.8	531	111	6.95	94.2	34.8
× 38.5	38.5	4 910	262	147	11.2	6.60	59.9	457	110	5.87	80.1	34.5
× 32.7	32.7	4 190	259	146	9.14	6.10	49.1	380	108	4.75	65.1	33.8
× 28.4	28.4	3 630	259	102	10.0	6.35	40.1	308	105	1.79	35.1	22.2
× 25.3	25.3	3 220	257	102	8.38	6.10	34.1	265	103	1.48	29.2	21.5
× 22.3	22.3	2 850	254	102	6.86	5.84	28.7	226	100	1.20	23.8	20.6
× 17.9	17.9	2 280	251	101	5.33	4.83	22.4	179	99.1	0.907	18.0	19.9
W200 × 100	100	12 700	229	210	23.7	14.5	113	990	94.5	36.9	351	53.8
× 86	86.0	11 000	222	209	20.6	13.0	94.9	852	92.7	31.3	300	53.3
× 71	71.0	9 100	216	206	17.4	10.2	76.6	708	91.7	25.3	246	52.8
× 59	59.0	7 550	210	205	14.2	9.14	60.8	582	89.7	20.4	200	51.8
× 52	52.0	6 650	206	204	12.6	7.87	52.9	511	89.2	17.7	174	51.6
× 46.1	46.1	5 880	203	203	11.0	7.24	45.8	451	88.1	15.4	152	51.3
× 41.7	41.7	5 320	205	166	11.8	7.24	40.8	398	87.6	9.03	109	41.1
× 35.9	35.9	4 570	201	165	10.2	6.22	34.4	342	86.9	7.62	92.3	40.9
× 31.3	31.3	3 970	210	134	10.2	6.35	31.3	298	88.6	4.07	60.8	32.0
× 26.6	26.6	3 390	207	133	8.38	5.84	25.8	249	87.1	3.32	49.8	31.2
× 22.5	22.5	2 860	206	102	8.00	6.22	20.0	193	83.6	1.42	27.9	22.3
× 19.3	19.3	2 480	203	102	6.48	5.84	16.5	162	81.5	1.14	22.5	21.4
× 15	15.0	1 910	200	100	5.21	4.32	12.8	128	81.8	0.870	17.4	21.4

W150 × 37.1	37.1	4 740	162	154	11.6	8.13	22.2	274	68.6	7.12	91.9	38.6
× 29.8	29.8	3 790	157	153	9.27	6.60	17.2	220	67.6	5.54	72.3	38.1
× 22.5	22.5	2 860	152	152	6.60	5.84	12.1	159	65.0	3.88	51.0	36.8
× 24	24.0	3 060	160	102	10.3	6.60	13.4	167	66.0	1.84	36.1	24.6
× 18	18.0	2 290	153	102	7.11	5.84	9.20	120	63.2	1.24	24.6	23.3
× 13.5	13.5	1 730	150	100	5.46	4.32	6.83	91.1	62.7	0.916	18.2	23.0
× 13	13.0	1 630	148	100	4.95	4.32	6.20	83.6	61.7	0.828	16.6	22.6
W130 × 28.1	28.1	3 590	131	128	10.9	6.86	10.9	167	55.1	3.80	59.5	32.5
× 23.8	23.8	3 040	127	127	9.14	6.10	8.91	140	54.1	3.13	49.2	32.0
W100 × 19.3	19.3	2 470	106	103	8.76	7.11	4.70	89.5	43.7	1.61	31.1	25.4

—13—

L-2/T-1/NAME **Date: 28/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **MME 293** (Shipbuilding Materials)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) A cylindrical specimen of steel (E = 210 GPa) having an original diameter of 12.8 mm is tensile tested to fracture and found to have an engineering yield strength of 300 MPa and an engineering fracture strength of 460 MPa. If its cross-sectional diameter at fracture is 10.7 mm, determine: (i) the ductility of the steel, (ii) the true stress at fracture and (iii) the true strain at yield point. **(5+5+5=15)**

   (b) "Obstructing the motion of dislocations is the main goal of various strengthening processes used for metal" — Justify the assertion correlating with various metal strengthening mechanism. **(20)**

2. (a) Both gray cast iron and nodular cast iron are solidification products. What is the basic difference between the two production parameters that is responsible to produce graphite flake in gray cast iron and spheroidal graphite in nodular cast iron? Compare the properties and applications of gray cast iron and nodular cast iron. **(15)**

   (b) Suppose you have to choose a suitable material for sea water environment from the following copper base alloys. Select one among the three materials with appropriate reasoning(s): (i) 70Cu – 30Zn, (ii) 60Cu – 38Zn – 2Pb and (iii) 60Cu – 39.25Zn – 0.75Sn. **(13)**

   (c) How does sensitization affect stainless steel? **(7)**

3. (a) Select and outline an NDT method suitable for detecting internal defect of a great. **(15)**

   (b) What problems do you face with sand cast magnesium alloys? How can you minimize these problems? **(10)**

   (c) Relate the microstructural characteristics of maraging steel with its mechanical properties. **(10)**

4. (a) Which of the common defects is most detrimental to timber? Place argument in favour of your choice. **(10)**

   (b) Describe the factors that affect T_g of glass. **(10)**

   (c) Select and describe a suitable process for manufacturing multiple polypropelyne (PP) boxes. **(15)**

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Metals X and Y of melting points 750°C and 920°C respectively are mutually soluble (completely) in the liquid state but partially soluble in the solid state. At 400°C a eutectic composition is formed with 60% X and 40% Y. At eutectic temperature the solubility of Y in X is 20% and that of X in Y is 15%, while at 0°C the solubility of Y in X is 8% and that of X in Y is 5%. Solid solution of Y in X is known as α phase and that of X in Y is known as β phase. **(12)**

   Draw the X-Y equilibrium phase diagram on graph paper, assuming all the liquidus and solidus lines to be straight and label all the phase fields.

   (b) Sketch and label the slow cooled microstructure of a 0.3% C and a 0.9% C steel at room temperature. Considering the composition of pearlite to be 0.76% C and that of ferrite to be 0.008% C which steel will contain more pearlite? Comment, with reasoning, on the mechanical properties of these two steels. **(15)**

   (c) The microstructure of an iron-carbon ally (steel) consists of pro-eutectoid ferrite and pearlite; the mass fractions of these microconstituents are 0.20 and 0.80, respectively. Determine the concentration of carbon in this alloy. Also, calculate the mass fraction of total ferrite and total cementite in the identified steel. **(8)**

6. (a) Explain how coring occurs with reference to copper-nickel phase diagram. Explain the problem associated with a cored structure and give a method of its rectification. **(17)**

   (b) Sketch and label the microstructural changes that occur in 0.35% C steel during equilibrium cooling from 900°C to room temperature. **(18)**

7. (a) Explain how a normalized hypoeutectoid steel achieve more hardness & strength than the annealed one. **(13)**

   (b) Explain the steps involved in steel making in an LD converter. Also, discuss its advantages and disadvantages. **(15+7=22)**

8. (a) Discuss the functions of each raw material used in a blast furnace and hence give an overview of pig iron production in a blast furnace. **(13)**

   (b) Explain the term "hardenability". How can the hardenability of steel be increased? **(7)**

   (c) How would you harden a surface by nitriding? Explain the advantages and disadvantages of nitriding over carburizing. **(15)**

L-2/T-1/NAME **Date: 04/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **MATH 281** (Vector Analysis and Differential Equation)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Solve the differential equation $\left(x^2D^2-2xD+2\right)y=x^2+\sin(5\ln x)$. **(18)**

   (b) Solve $\left[xD^2+(1-x)D-2(1+x)\right]y=e^{-x}(1-6x)$ by the method of operational factors. **(17)**

2. Use the method of Frobenius to find solutions of the differential equation **(35)**

$$2x^2\frac{d^2y}{dx^2}-x\frac{dy}{dx}+(x-5)y=0$$

3. (a) Prove that $P_n(x)$ is the coefficient of t^n in the expansion of $\left(1-2xt+t^2\right)$ in ascending power of t. **(17)**

   (b) Establish the recurrence relation **(18)**

$$(2n+1)xP_n(x)=(n+1)P_{n+1}(x)+nP_{n-1}(x)$$

Hence prove that $\int_{-1}^{1}x^2P_n^2(x)dx=\frac{1}{8(2n-1)}+\frac{3}{4(2n+1)}+\frac{1}{8(2n+3)}$.

4. (a) Prove that **(20)**

   (i) $xJ_n'(x)=nJ_n(x)-xJ_{n+1}(x)$

   (ii) $J_{\frac{1}{2}}(x)=\sqrt{\frac{2}{\pi x}}\sin x$

   (b) Show that **(15)**

$$J_n(x)=\frac{1}{\pi}\int_0^{\pi}\cos(n\varphi-x\sin\varphi)d\varphi,$$ when n is a positive integer.

Contd P/2

MATH 281/NAME

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Prove that the area of the triangle formed by joining the mid-point of one of the non-parallel sides of a trapezium to the extremities of the opposite side is half of that of the trapezium. **(15)**

   (b) Show that the vectors $A = 2\mathbf{i} + \mathbf{j} - 3\mathbf{k}$, $B = \mathbf{i} - 4\mathbf{k}$ and $C = 4\mathbf{i} + 3\mathbf{j} - \mathbf{k}$ are linearly dependent. Determine a relation among them and hence show that the terminal points are collinear. **(10)**

   (c) A force of 15 units acts through point A (4, 1, –3) in the direction of the vector (3, 1, 5). Find its moment about the point B (2, –3, –1) and the moment about axes through that point parallel to the co-ordinate axes. **(10)**

6. (a) If $\mathbf{P} = \mathbf{A}\cos kt + \mathbf{B}\sin kt$, where **A** and **B** are constant vectors and k, a constant scalar, then find $\frac{d^2\mathbf{P}}{dt^2} + k^2\mathbf{P}$. **(10)**

   (b) State and prove Frenet-Serret formulae. **(15)**

   (c) Solve the vector equation $\mathbf{a} \times \mathbf{x} + \mathbf{a}(\mathbf{a}\cdot\mathbf{x}) + \mathbf{b} = \mathbf{0}$ for the vector **x**. **(10)**

7. (a) Find the acute angle between the surfaces $xy^2z = 3x + z^2$ and $3x^2 - y^2 + 2z - 1 = 0$ at (1, –2, 1). **(10)**

   (b) Find $\nabla^2(r^n\,\mathbf{r})$ where **r** is the position vector. **(15)**

   (c) Show that $\nabla\times(\mathbf{A}\times\mathbf{B}) = \mathbf{A}(\nabla.\mathbf{B}) - \mathbf{B}(\nabla.\mathbf{A}) - (\mathbf{A}.\nabla)\mathbf{B} + (\mathbf{B}.\nabla)\mathbf{A}$ **(10)**

8. (a) Find the work done by the force field **F** on a particle that moves along the curve C where $\mathbf{F} = (3x^2 - 2y)\mathbf{i} + (y^2 + 3x^2)\mathbf{j} + (2zy - 5x)\mathbf{k}$ and C is the curve defined by line segments from (0, 0, 0) to (1, 2, –1) to (–2, –1, –3). **(15)**

   (b) State and verify the Gauss divergence theorem for $\mathbf{F} = 2x^2y\,\mathbf{i} - y^2\,\mathbf{j} + 4xz^2\,\mathbf{k}$ taken over the region in the first octant bounded by $y^2 + z^2 = 9$ and $x = 0, x = 3$. **(20)**

L-2/T-1/NAME **Date: 06/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2021-2022

Sub: **HUM 113** (Economics)

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Define demand function. **(5)**

(b) What are the main determinants of demand? Explain. **(10)**

(c) What are the exceptions to the law of demand? **($8\frac{1}{3}$)**

2. (a) Show that price elasticity of demand varies from zero to infinity along any straight line demand curve. Explain graphically. **($13\frac{1}{3}$)**

(b) From the following table calculate elasticity of demand if you move from point A to C and explain what you understand from the result. **(10)**

POINT	Py	Qx
A	500	150
B	600	160
C	700	170

3. (a) What is an indifference curve? Explain the properties of an indifference curve. **(15)**

(b) Consumers attain equilibrium at the point of tangency between the indifference curve and the budget line-discuss. **($8\frac{1}{3}$)**

4. (a) How is price determined in an open economy? What will happen to the price and quantity due to change in demand? **(10)**

(b) From the following demand and supply functions, calculate equilibrium price and quantity and show that result in a graph. **($13\frac{1}{3}$)**

$$P = 0.40\,Q + 20$$

$$P = -0.30\,Q + 90$$

(i) What will happen to the equilibrium price and quantity if government imposes a unit tax of TK 10?

(ii) Describe the change in equilibrium. Show the equilibrium coordinates on the same graph.

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Clarify the concepts of 'short run' and 'long run' in the theory of production and explain the law of diminishing marginal returns in production. **(10)**

   (b) Describe the relationship between total physical product (TPP), average physical product (APP) and marginal physical product (MPP). Use diagrams. **($13\frac{1}{3}$)**

6. (a) What are the possible situations that firms usually experience in terms of returns to scale (RTS) of production? Describe them and explain the economies and diseconomies of scale of production with reference to RTS. **(10)**

   (b) Describe the loss minimizing point and the shut-down point under perfect competition. The following are respectively the Average Revenue (AR) and Total Cost (TC) functions of a firm. **($13\frac{1}{3}$)**

   $$AR = 1400Q^{-1} - 7.5Q$$
   $$TC = Q^3 - 6Q^2 + 140Q + 750$$

   Find the maximum profit maximizing level of output and maximum profit.

7. (a)Distinguish between the terms given below **(10)**

   (i) Gross Domestic Product (GDP) and Gross National Income (GNY)

   (ii) Consumer Price Index (CPI) and GDP deflator.

   (b) What is inflation? Describe the causes and consequences of inflation. How is inflation measured? Explain with hypothetical data. **($13\frac{1}{3}$)**

8. Write Short Notes on any **THREE** of the following **($23\frac{1}{3}$)**

   (i) Short run and long run cost curves

   (ii) Monopolistic competition market

   (iii) National income accounting

   (iv) Fiscal Policy and Monetary Policy
