

D.P.H.

L-2/T-1/NAME

Date : 31/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **HUM 113** (Economics)

Full Marks : 140

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**.

1. (a) Explain the long-run equilibrium of a firm under perfect competition. (10)  
 (b) From the following revenue and cost function, calculate profit maximizing level of output and maximum profit. (8 1/3)

$$R = 1000Q - 2Q^2$$

$$C = Q^3 - 59.25Q^2 + 1235.5Q + 3000$$

- (c) What are the assumptions of a perfectly competitive market? (5)
2. (a) Prove that  $MR = P \left( 1 - \frac{1}{e} \right)$  (5)

where MR = Marginal revenue

P = Price

e = Price elasticity of demand

- (b) Why is there no unique supply curve for the monopolist derived from his marginal cost curve? Explain graphically. (10)  
 (c) When does a firm emerge as a monopolist? (8 1/3)

3. (a) Define fixed cost and variable cost. (5)  
 (b) How would you derive the long-run average cost curve of a firm from its short-run average cost curves? (10)  
 (c) What is the relation among various short-run cost curves? Explain graphically. (8 1/3)

4. (a) Define production function. (5)  
 (b) Explain producer's equilibrium with the help of isoquant and iso-cost curve. (10)  
 (c) From the following function, calculate the amount of labour and capital that maximize output. What is the maximum amount of output? (8 1/3)

$$Q = 300L^{0.07} K^{0.06}$$

$$1500 = 30L + 50K$$

Contd ..... P/2

**HUM 113**

**SECTION – B**

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

5. (a) Distinguish between the concepts of microeconomics and macroeconomics. Briefly discuss the relative importance of microeconomics and macroeconomics in the formation of national economic policies of a country. (8)
- (b) Explain graphically the 'change in demand' and 'change in the quantity demanded' with reference to the change in prices of substitute and complementary commodities. (7 1/3)
- (c) Mathematically derive the cardinal theory of consumer equilibrium both for independent and interdependent commodities. (8)
6. (a) Narrate the factors that affect the supply of a commodity in general. (8 1/3)
- (b) Define market equilibrium. Describe how the price of a commodity in the market is determined. (8)
- (c) Calculate the equilibrium price and the equilibrium quantity from the following market demand function and market supply function (7)
- $QD_x = 1500 - 30 P_x$
- $QS_x = -500 + 50 P_x$
7. (a) Discuss in detail price elasticity of demand, income elasticity of demand and cross elasticity of demand. (13 1/3)
- (b) Explain the concept of marginal rate of substitution. (5)
- (c) What is meant by the budget constraint line? Explain graphically. (5)
8. (a) Define an indifference curve. Make a hypothetical indifference schedule, plot the schedule on a graph and explain. (5)
- (b) What do you understand by substitution effect and income effect of a price change? (5)
- (c) Derive a demand curve with the help of indifference curve and show that price effect is equal to substitution effect and income effect. Present and explain all necessary diagrams. (13 1/3)
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L-2/T-1/NAME

Date : 07/01/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2011-2012

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

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**.

1. (a) Write down the classification of I.C engines. (10)
- (b) Draw and discuss the P-V diagram for a diesel engine. (12)
- (c) For a diesel engine, show that (13)

$$\eta = 1 - \frac{1}{C_R^{k-1}} \left[ \frac{\left(\frac{V_3}{V_2}\right)^k - 1}{k \left(\frac{V_3}{V_2} - 1\right)} \right]$$

where symbols have their usual meanings.

2. (a) Discuss the different types of fuels which are used for the combustion engine. (25)
- (b) Explain what is meant by an octane rating of 80 and a cetane rating of 70. (10)
3. (a) What are the differences between a wet liner and a dry liner? State their advantages and disadvantages. (10)
- (b) State the functions of compression rings and oil rings fitted in piston of I.C engines. What are the reasons for using more than one compression ring? (10)
- (c) Discuss in brief the factors which affect the performance of I.C engines. (15)
4. (a) What types of combustion chambers are usually used in marine diesel engines? Discuss. (15)
- (b) Explain the following systems of C.I. engines. (20)
  - (i) Fuel supply system
  - (ii) Lubrication system
  - (iii) Cooling system
  - (iv) Fuel control system.

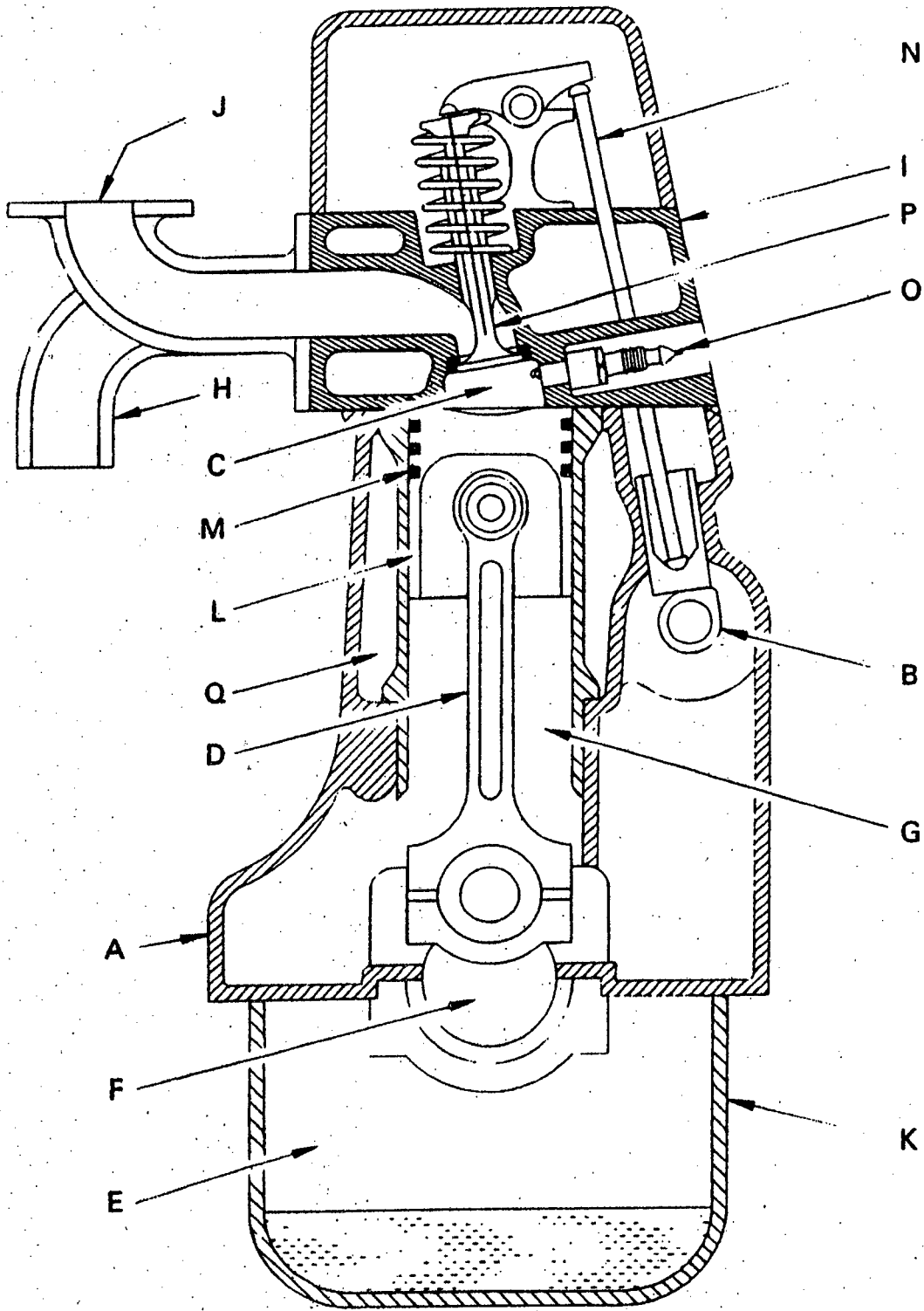
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**NAME 219**

**SECTION - B**

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

5. (a) Name five new and renewable sources of energy. Show how energy from ocean wave can be harnessed by OWC (oscilating water column)-give a neat free hand sketch. (15)
- (b) Name the components as shown in the Fig. 5(b), by English alphabets of a 4-stroke IC engine. (neither draw the diagram nor attach it with the script, just write the alphabets and name these in your script). (20)
6. (a) Draw the block diagram of a simple cycle gas turbine producing power. Depict the cycle on p-v and T-S diagrams and hence find an expression for its efficiency. (20)
- (b) Draw the block diagrams and the corresponding T-S diagrams for the following gas turbine cycles. (15)
- (i) Simple cycle with heat exchange (regeneration)
  - (ii) Reheat cycle
  - (iii) Reheat cycle with regeneration.
7. (a) Write a brief note on fuel metering in SI engine. (10)
- (b) A 3.5" × 4.5" eight cylinder, 4-stroke SI engine runs at 2500 rpm. The carburettor throat diameter is 1.25". Determine the depression at the venturi at a standard outside pressure if volumetric efficiency 75%. Derive the expressions used. (25)
8. (a) With a neat and simplified flowchart show how petroleum products (gasoline, diesel) are obtained from crude oil by distillation and refining. (25)
- (b) Write a brief note on Marine fuel. (10)
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Cross-section of four-stroke cycle SI engine showing engine components.

fig. for Q.5(b)

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14.01.13

L-2/T-1/NAME

Date : 19/11/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2011-2012

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

Full Marks: 210

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

**SECTION - A**

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

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

1. (a) A steel bar, 1 m in length and  $35 \times 35$  mm in cross section, is rigidly attached to a wall at its right end. Its other end is 0.5 mm from another rigid wall. If a 120 kN axial force is attached to the bar at its midpoint and the temperature is increased by  $60^\circ\text{C}$ , what will be the unit stress in each portion of the bar? (20)  
 $E = 207 \text{ GN/m}^2$   
 $\alpha = 0.0000117$   
(b) A rigid block of mass  $M$  is supported by three symmetrically spaced rods as shown in Fig. for Q. No. 1(b). Each copper rod has an area of cross section of  $900 \text{ mm}^2$ ;  $E = 120 \text{ GPa}$ ; and the allowable stress is 70 MPa. The steel rod has an area of cross section of  $1200 \text{ mm}^2$ ;  $E = 200 \text{ GPa}$ ; and the allowable stress is 140 MPa. Determine the largest mass  $M$  which can be supported. (15)
2. (a) Draw the shear force and bending moment diagram for the loaded beam as shown in Fig. For Q. No. 2(a). (20)  
(b) Determine the shear force and bending moment as functions of  $x$ , for the loaded cantilever beam as shown in Fig. for Q. No. 2(b). (15)
3. (a) A simply supported beam 10 m long carries a uniformly distributed load of 20 kN/m over its entire length and a concentrated load of 40 kN at midspan. If the allowable stress is 120 MPa, determine the lightest W shape beam that can be used. (20)  
(b) What should be the total depth of the cast-iron T section as shown in Fig. for Q. No. 3(b), in order to produce simultaneously occurring tensile and compressive stresses of 55.0 MPa and 110.0 MPa at A and B, respectively? (15)
4. (a) Determine the moment of inertia of the shaded area as shown in Fig. for Q. No. 4(a) with respect to the  $x$  axis when  $a = 20$  mm. (15)  
(b) How can you measure the ductility of a material? (8)  
(c) Define the followings: (12)
  - (i) Critical buckling load
  - (ii) Slenderness ratio
  - (iii) Yield strength.

Contd ..... P/2

**NAME 251**

**SECTION - B**

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

5. (a) Derive an expression relating the applied twisting moment acting on a shaft of circular cross-section and the shearing stress of any point in the shaft. (20)
- (b) A shaft composed of segments, AC, CD and DB is fastened to rigid supports and loaded as shown in Fig. for Q. No. 5(b). For bronze  $G = 35$  GPa; for aluminium  $G = 28$  GPa and for steel  $G = 83$  GPa. Determine the maximum shearing stress developed in each segment. (15)
6. (a) Determine the slope and deflection equations for the simply supported beam having a concentrated load at its centre by double integration method. (20)
- (b) Determine the deflection curve of a simply supported beam subject to a concentrated moment as shown in Fig. for Q. No. 6(b) by step-function method. (15)
7. (a) Determine the internal forces carried by all the beams in the pin-jointed frame (all angles are  $45^\circ$  or  $90^\circ$  and the length of AB is L) as shown in Fig. for Q. No. 7(a). (15)
- (b) Calculate the reactions at the supports and draw the shear force and bending moment diagrams of the beam as shown in Fig. for Q. No. 7(b). (20)
8. (a) Consider a plane element subject to normal and shearing stresses  $\sigma_x$ ,  $\sigma_y$  and  $\tau_{xy}$  respectively. Determine the normal and shearing stress intensities on a plane inclined at an angle  $\theta$  to the normal stress  $\sigma_x$ . (15)
- (b) A plane element is subject to the stresses shown in Fig. for Q. No. 8(b). Determine (20)
- (i) the principal stresses and their directions
- (ii) the maximum shearing stresses and the directions of the planes of which they occur.
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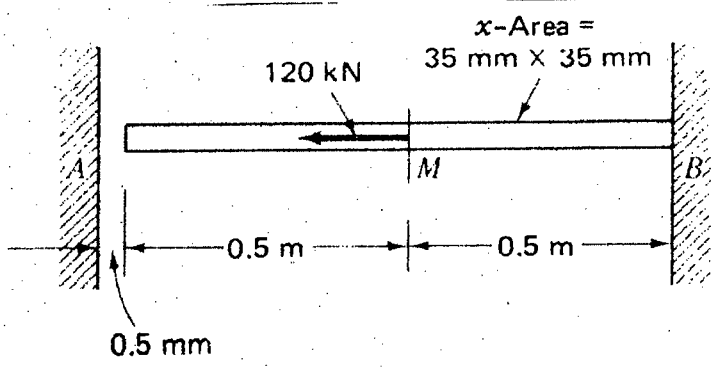


Fig. for Q. No. 1(a)

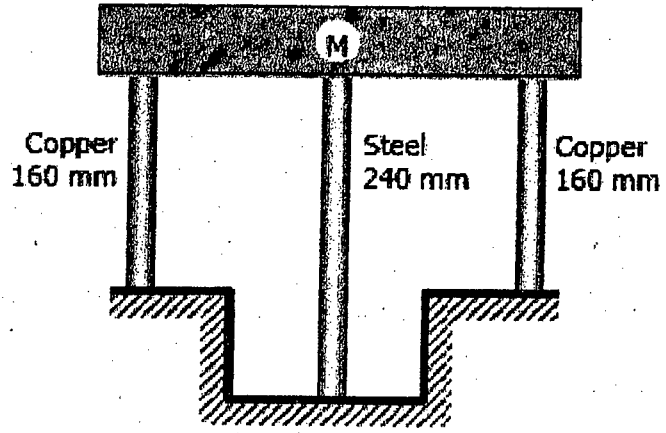


Fig. for Q. No. 1(b)

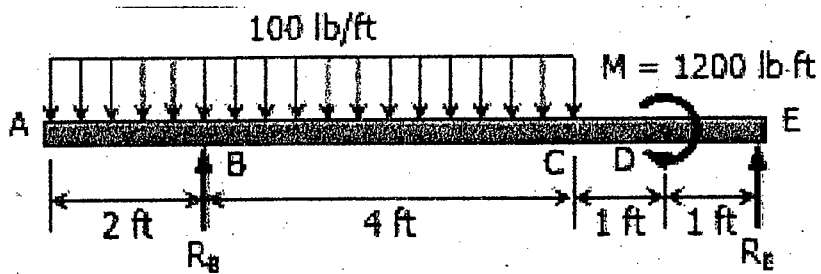


Fig. for Q. No. 2(a)

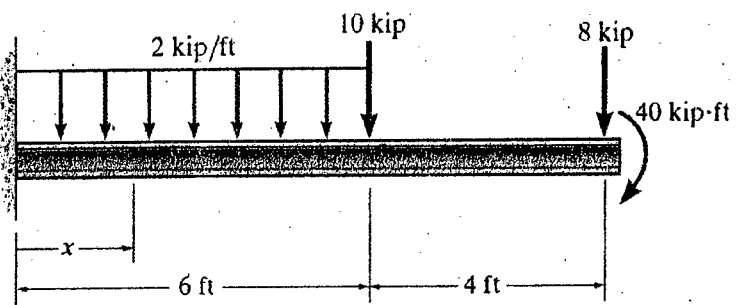


Fig. for Q. No. 2(b)

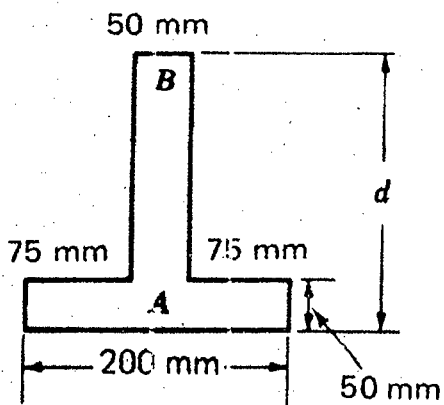


Fig. for Q. No. 3(b)

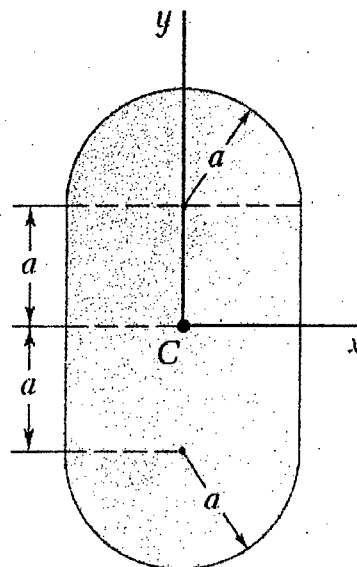
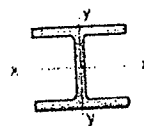


Fig. for Q. No. 4(a)



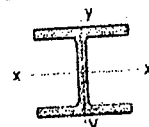
Table for Q. No. 3(a).

W Shapes  
Wide-Flange I-Beams  
SI Units



Section Number	Mass kg/m	Area mm <sup>2</sup>	Depth mm	Width mm	thickness		x-x axis			y-y axis		
					Web mm	Flange mm	I <sub>x</sub> 10 <sup>6</sup> mm <sup>4</sup>	S <sub>x</sub> 10 <sup>3</sup> mm <sup>3</sup>	r <sub>x</sub> mm	I <sub>y</sub> 10 <sup>6</sup> mm <sup>4</sup>	S <sub>y</sub> 10 <sup>3</sup> mm <sup>3</sup>	r <sub>y</sub> mm
W610 x 155	155	19,800	611	324	12.7	19.0	1,290	4,220	255	108	667	73.9
x 140	140	17,900	617	230	13.1	22.2	1,120	3,630	250	45.1	392	60.2
x 125	125	15,900	612	229	11.9	19.6	925	3,220	249	39.3	343	49.7
x 113	113	14,400	606	228	11.2	17.3	875	2,880	247	34.3	301	48.8
x 101	101	12,900	603	228	10.5	14.9	764	2,530	243	29.5	259	47.8
x 92	92	11,800	603	179	10.9	15.0	646	2,140	234	14.4	161	34.9
x 82	82	10,500	599	178	10.3	12.8	560	1,870	231	12.1	136	33.9
W460 x 106	106	13,500	469	194	12.6	20.6	488	2,060	190	25.1	259	43.1
x 97	97	12,300	466	193	11.4	19.0	445	1,910	190	22.8	236	42.8
x 89	89	11,400	463	192	10.5	17.7	410	1,770	190	20.9	218	42.3
x 82	82	10,400	460	191	9.91	16.0	370	1,610	189	18.6	195	42.3
x 74	74	9,460	457	190	9.02	14.5	333	1,460	188	16.6	175	41.9
x 68	68	8,730	459	154	9.14	15.4	297	1,290	184	9.41	122	32.8
x 60	60	7,590	455	153	8.00	13.3	255	1,120	183	7.96	104	32.4
x 52	52	6,640	450	152	7.62	10.8	212	942	179	6.34	83.4	30.9
W410 x 100	100	12,700	415	260	10.0	16.9	398	1,920	177	49.5	381	62.4
x 85	85	10,800	417	181	10.9	18.2	315	1,510	171	18.0	199	40.8
x 74	74	9,510	413	180	9.65	16.0	275	1,330	170	15.6	173	40.5
x 67	67	8,560	410	179	8.76	14.4	245	1,200	169	13.8	154	40.2
x 53	53	6,820	403	177	7.49	10.9	186	923	165	10.1	114	38.5
x 46	46	5,890	403	140	6.99	11.2	156	774	163	5.14	73.4	29.5
x 39	39	4,960	399	140	6.35	8.8	126	632	159	4.02	57.4	28.5
W360 x 101	101	12,900	357	255	13.5	18.3	302	1,690	153	50.6	397	62.6
x 91	91	11,600	353	254	9.5	16.4	267	1,510	152	44.8	353	62.1
x 79	79	10,100	364	205	9.40	16.8	227	1,280	150	24.2	236	48.9
x 64	64	8,150	347	203	7.75	13.5	179	1,030	148	18.8	185	48.0
x 57	57	7,200	358	172	7.87	13.1	160	894	149	11.1	129	39.3
x 51	51	6,450	355	171	7.24	11.6	141	754	148	9.68	113	38.7
x 45	45	5,710	352	171	6.86	9.8	121	628	146	8.16	95.4	37.8
x 39	39	4,960	353	128	6.48	10.7	102	578	143	3.75	58.6	27.5
x 33	33	4,160	349	127	5.84	8.5	82.9	475	141	2.91	45.8	26.4

W Shapes  
Wide-Flange I-Beams  
SI Units



Section Number	Mass kg/m	Area mm <sup>2</sup>	Depth mm	Width mm	thickness		x-x axis			y-y axis		
					Web mm	Flange mm	I <sub>x</sub> 10 <sup>6</sup> mm <sup>4</sup>	S <sub>x</sub> 10 <sup>3</sup> mm <sup>3</sup>	r <sub>x</sub> mm	I <sub>y</sub> 10 <sup>6</sup> mm <sup>4</sup>	S <sub>y</sub> 10 <sup>3</sup> mm <sup>3</sup>	r <sub>y</sub> mm
W310 x 107	107	13,600	311	306	10.9	17.0	248	1,590	135	81.2	531	77.3
x 97	97	12,300	308	305	9.90	15.4	222	1,440	134	72.9	478	77.0
x 86	86	11,000	310	254	9.10	16.3	199	1,280	135	44.5	351	63.6
x 74	74	9,480	310	205	9.40	16.3	165	1,060	132	23.4	228	49.7
x 67	67	8,530	306	204	8.51	14.6	145	948	130	20.7	203	49.3
x 39	39	4,930	310	165	5.84	9.7	84.8	547	131	7.23	87.6	38.3
x 33	33	4,180	313	102	6.60	10.8	65.0	415	125	1.92	37.6	21.4
x 24	24	3,040	305	101	5.59	6.7	42.8	281	119	1.16	23.0	19.5
x 21	21	2,680	303	101	5.08	5.7	37.0	244	117	0.986	19.5	19.2
W250 x 101	101	12,900	264	257	11.9	19.6	164	1,240	113	55.5	432	65.6
x 80	80	10,200	256	255	9.40	15.6	126	984	111	43.1	338	65.0
x 67	67	8,560	257	204	8.89	15.7	104	809	110	22.2	218	50.9
x 58	58	7,400	252	203	8.00	13.5	87.3	693	109	18.8	185	50.4
x 45	45	5,700	266	148	7.62	13.0	71.1	535	112	7.03	95	35.1
x 28	28	3,620	260	102	6.35	10.0	39.9	307	105	1.78	34.9	22.2
x 22	22	2,850	254	102	5.84	6.9	28.8	227	101	1.22	23.9	20.7
x 18	18	2,280	251	101	4.83	5.3	22.5	179	99.3	0.919	18.2	20.1
W200 x 100	100	12,700	229	210	14.5	23.7	113	987	94.3	36.6	349	53.7
x 86	86	11,000	222	209	13.0	20.6	94.7	853	92.8	31.4	300	53.4
x 71	71	9,100	216	206	10.2	17.4	76.6	709	91.7	25.4	247	52.8
x 59	59	7,580	210	205	9.14	14.2	61.2	583	89.9	20.4	199	51.9
x 46	46	5,890	203	203	7.24	11.0	45.5	448	87.9	15.3	151	51.0
x 36	36	4,570	201	165	6.22	10.2	34.4	342	86.8	7.64	92.6	40.9
x 22	22	2,660	206	102	6.22	8.0	20.0	194	83.6	1.42	27.8	22.3
W150 x 37	37	4,730	162	154	8.13	11.6	22.2	274	68.5	7.07	91.8	38.7
x 30	30	3,790	157	153	6.60	9.3	17.1	218	67.2	5.54	72.4	38.2
x 22	22	2,860	152	152	5.84	6.6	12.1	159	65.0	3.87	50.9	36.8
x 24	24	3,060	160	102	6.60	10.3	13.4	168	66.2	1.83	35.9	24.5
x 18	28	2,290	153	102	5.84	7.1	9.19	120	63.3	1.26	24.7	23.5
x 14	14	1,730	150	100	4.32	5.5	6.84	91.2	62.9	0.914	18.2	23.0

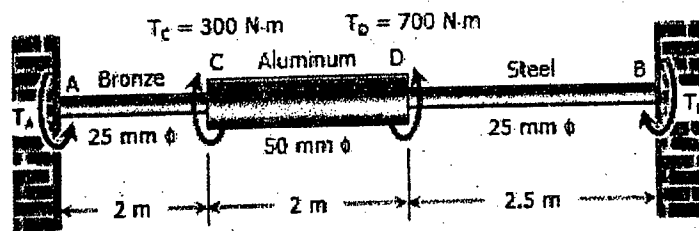


Fig. for Q. No. 5(b)

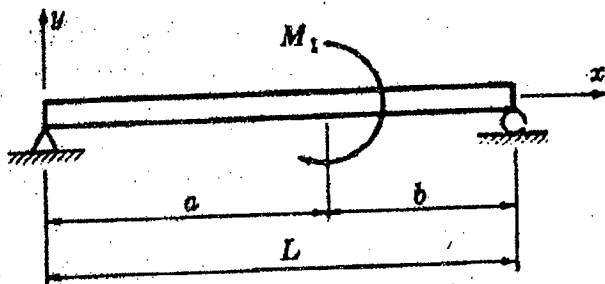


Fig. for Q. No. 6(b)

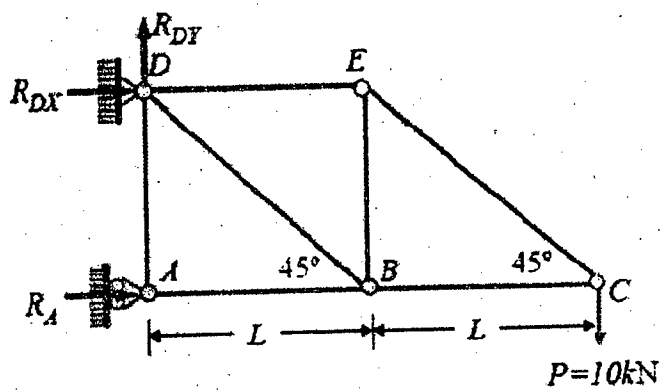


Fig. for Q. No. 7(a)

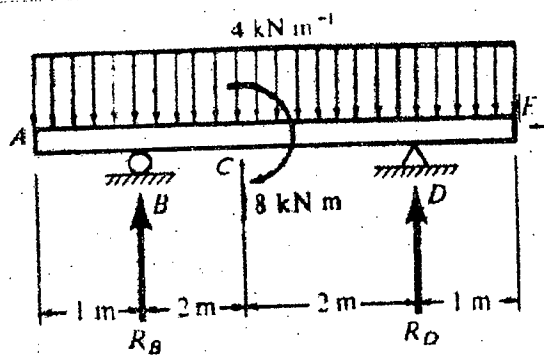


Fig. for Q. No. 7(b)

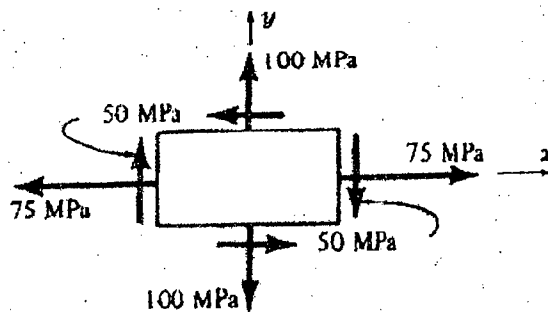


Fig. for Q. No. 8(b)

Nazim Nazim  
24/12/12

L-2/T-1/NAME

Date : 24/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2011-2012

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**.

1. (a) Draw a cross-section of a blast furnace showing various raw materials and products. (18)  
(b) How does a dust catcher remove dust from blast furnace gas? Explain with necessary sketch. (12)  
(c) What are the main five components of a modern blast furnace plant? (5)
2. (a) Describe briefly how steel is produced using an open hearth furnace. (15)  
(b) Compare Bessemer and L-D processes of steel making. (12)  
(c) Why is an electric furnace now-a-days utilized during steel making process? (8)
3. (a) What are the conditions to determine the usefulness of an oxide layer in preventing base material from adverse environment? (6)  
(b) Draw the structure of a timber tree showing different layers. (6)  
(c) Describe the type and prevention technique of corrosion that occurs in improperly heat treated 18/8 stainless steel. (15)  
(d) Differentiate between natural cement and artificial cement. (8)
4. (a) Mention different types of stainless steels along with their compositions, properties and uses. (18)  
(b) Briefly describe the process of producing electrolytic touch pitch copper. (12)  
(c) List five advantages of alloy steel. (5)

**SECTION – B**

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

5. (a) Draw the iron-ironcarbide equilibrium diagram on a piece of graph paper and label it completely. (15)  
(b) Explain the isothermal lines on the Fe-Fe<sub>3</sub>C equilibrium diagram. (8)  
(c) Discuss the differences in microstructures and properties one would expect if a hypoeutectoid steel is annealed and normalized from the same heat-treatment temperature. (12)

Contd ..... P/2

**MME 293**

6. (a) What are the basic types of cast irons? Draw the microstructure and mention the important uses of each type. (15)
- (b) How are ferritic and pearlitic malleable cast irons are produced from white cast iron? Draw the heat-treatment cycles and show the gradual microstructural changes during those cycles. (20)
7. (a) What is creep? Draw a creep curve for tensile loading showing the stages and explain the possible reasons for those stages of the curve. Mention the effects of increasing stresses and temperatures on the curve. (20)
- (b) What is strain hardening? How can one increase strength of metals or alloys by using this phenomenon? Illustrate this with the help of a stress-strain curve. (15)
8. (a) What is the purpose of surface hardening? Describe how a low carbon steel part is carburized by the process of pack carburization stating the mechanism involved in the process. (17)
- (b) Name the common non-destructive testing techniques. Mention two suitable techniques for inspection of materials to identify hidden and surface defects respectively. With diagrams, describe the working principle of ultrasonic testing to identify a defect in a finished product. (18)
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*Refat.*

L-2/T-1/NAME

Date : 17/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2011-2012

Sub : **MATH 281** (Differential Equations (Special type) and Vector Analysis)

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

**SECTION - A**

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

1. (a) Solve the following differential equation by the method based on the factorization of the operator  $[xD^2 + (1-x)D - 2(1+x)]y = e^{-x}(1-6x)$ . (18)
- (b) Solve  $(x^2D^2 - 3xD + 4)y = x + x^2 \ln x$ . (17)
  
2. (a) Show that  $(1 - 2xh + h^2)^{-1/2}$  is the generating function for Legendre's polynomial. (13)
- (b) Prove that  $\frac{d}{dx} [x^n J_n(x)] = x^n J_{n-1}(x)$ . (10)
- (c) Prove that  $P_n(x) = \frac{1}{\pi} \int_0^\pi [x \pm \sqrt{x^2 - 1} \cos \theta]^n d\theta$ , where  $n$  is a positive integer. (12)
  
3. (a) Prove that  $J_n(x)$  and  $J_{-n}(x)$  are linearly dependent when  $n$  is any integer. (12)
- (b) Express  $f(x) = x^4 + 2x^3 + 2x^2 - x - 3$  in terms of Legendre polynomials. (12)
- (c) Prove that  $J_{-3/2}(x) = -\sqrt{\frac{2}{\pi x}} \left( \frac{\cos x}{x} + \sin x \right)$ . (11)
  
4. Solve in series the following differential equation by using the method of Fröbenius (35)  
$$x^2 y'' + xy' + (x^2 - 1)y = 0.$$

Contd ..... P/2

**MATH 281****SECTION - B**

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

5. (a) Test the dependency of the set of vectors  $\{(1, 2, -3), (2, 0, -1), (7, 6, -11)\}$ . If dependent find a relation among them. (10)

- (b) A rigid body is rotating with an angular velocity  $\frac{\pi}{4}$  radians per second about an axis which passes through a point  $(-1, 3, 2)$  having direction cosines proportional to  $3, 2, 7$ . Find the linear velocity of the point  $(9, 11, -7)$  of the body. (15)

- (c) Prove that the medians of a triangle meet in a point which is a point of trisection of the medians. (10)

6. (a) A vector satisfies the equations  $\bar{x} \times \bar{b} = \bar{c} \times \bar{b}$  and  $\bar{x} \cdot \bar{a} = 0$ . Prove that  $\bar{x} = \bar{c} - \frac{(\bar{a} \cdot \bar{c})\bar{b}}{\bar{a} \cdot \bar{b}}$ . (15)

- (b) Find  $\bar{T}, \bar{N}, \bar{B}, \kappa, \lambda$  for the equation of the osculating plane of the curve  $x = 3t, y = 3t^2, z = 2t^3$  at  $t = 1$ . (20)

7. (a) Prove that  $\text{div}(\bar{F} \times \bar{G}) = \bar{G} \cdot \text{curl} \bar{F} - \bar{F} \cdot \text{curl} \bar{G}$ . (5)

- (b) If  $\bar{F} = (x^3z - 2xyz)\bar{i} + (xy - 3x^2yz)\bar{j} + (yz^2 - xz)\bar{k}$  is solenoidal then find a vector  $\bar{V}$  such that  $\bar{F} = \nabla \times \bar{V}$ . (15)

- (c) Evaluate  $\iint_S (y^2z\bar{i} + z^2x\bar{j} + x^2y\bar{k}) dS$  where  $S$  is the surface of the sphere  $x^2 + y^2 + z^2 = 4$  lying in the positive octant. (15)

8. (a) State Green's Theorem. Evaluate by Green's Theorem in the plane for  $\oint_C e^{-x} \sin y dx + e^{-x} \cos y dy$  where  $C$  the rectangle with vertices  $(0, 0), (\pi, 0), (\pi, \pi/2)$  and  $(0, \pi/2)$ . (15)

- (b) Verify Gauss's Divergence theorem for  $\bar{F} = 2x^2\bar{i} - y^2\bar{j} + 4xz\bar{k}$  taken over the region  $S$  in the first octant bounded by  $y^2 + z^2 = 9, x = 0$  and  $x = 2$ . (20)

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