Self-Study/ME **Date: 03/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations

Sub: **IPE 381** (Measurement and Quality Control)

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 probability that a doctor correctly diagnoses and particular illness is 0.7. Given that the doctor makes an incorrect diagnosis, the probability that the patient enters a law suit is 0.9. What is the probability that the doctor makes an incorrect diagnosis and the patient sues? **(15)**

   (b) Prove that the variance of a discrete random variable X can be expressed as: **(12)**

   $$\sigma^2 = E(x^2) - \mu^2$$

   Where the symbols bear their usual meanings.

   (c) Discuss the four levels of data. Provide suitable examples. **(8)**

2. (a) A component part for an electric car engine is to be manufactured by molding process. The sprue-opening on this molding is an important variable of the part. Measurements for this sprue-opening for 20 samples of size 5 are listed in the table below. Find the control limits for $\overline{X}$ and R charts, construct the chart, and plot the data. What observation can you make by plotting the graph? **(30)**

Sample Number	x_1	x_2	x_3	x_4	x_5
1	33	29	31	32	33
2	33	31	35	37	31
3	35	37	33	34	36
4	30	31	33	34	33
5	33	34	35	33	34
6	38	37	39	40	38
7	30	31	32	34	31
8	29	39	38	39	39
9	28	33	35	36	43
10	38	33	32	35	32
11	28	30	28	32	31
12	31	35	35	35	34
13	27	32	34	35	37
14	33	33	35	37	36
15	35	37	32	35	39
16	33	33	27	31	30
17	35	34	34	30	32
18	32	33	30	30	33
19	25	27	34	27	28
20	35	35	36	33	30

   (b) Explain the two types of causes that are responsible for variations in a process. **(5)**

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3. (a) The increased availability of light materials with high strength has revolutionized the design and manufacture of golf clubs, particularly drivers. Clubs with hollow heads and very thin faces can result in much longer tee shots, especially for players of modest skills. This is due partly to the "spring-like effect" that the thin face imparts to the ball. Firing a golf ball at the head of the club and measuring the ratio of the outgoing velocity of the ball to the incoming velocity can quantify this spring-like effect. The ratio of velocities is called the coefficient of restitution of the club. An experiment was performed in which 15 drivers produced by a particular club maker were selected at random and their coefficients of restitution measured. In the experiment the golf balls were fired from an air cannon so that the incoming velocity and spin rate of the ball could be precisely controlled. Is there any evidence to support a claim that the mean coefficient of restitution exceeds 0.82? Take $\alpha = 0.05$. The observations are given below: **(20)**

0.8411	0.8191	0.8182	0.8125	0.8750
0.8580	0.8532	0.8483	0.8276	0.7983
0.8042	0.8730	0.8282	0.8359	0.8660

The sample mean and sample standard deviation are 0.83725 and 0.02456 respectively.

(b) A nationwide survey of 17,000 seniors by the University of Michigan revealed that almost 70% disapprove of daily smoking. If 18 of these seniors are selected at random and asked their opinions, what is the probability that more than 9 but less than 14 disapprove of smoking? **(15)**

4. (a) A lawyer commutes daily from his susurban home to his midtown office. The average time for one-way trip is 24 minutes, with a standard deviation of 3.8 minutes. Assume the distribution of trip times to be normally distributed. **(20)**

   (i) What is the probability that a trip will take at least 1/2 hours?

   (ii) If the office opens at 9:00 A.M. and he leaves his house at 8:45 A.M. daily, what percentage of the time is he late for work?

   (iii) If he leaves the house at 8:35 A.M. and coffee is served at the office from 8:50 A.M. until 9:00 A.M., what is the probability that he misses coffee?

   (iv) Find the probability that 2 of the next 3 trips will take at least 1/2 hours.

(b) Determine the value c so that each of the following functions can serve as a probability distribution of the discrete random variable X: **(10)**

(a) $f(x) = c(x^2 + 4)$, for $x = 0,1,2,3$;

(b) $f(x) = c\binom{2}{x}\binom{3}{3-x}$, for $x = 0,1,2$

Contd P/3

(c) What do you understand by *skewness* and *COV*? Provide mathematical definition for both. **(5)**

SECTION – B

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

Assume any missing data.

5. (a) What are the functions of secondary lock which is situated at the top of one of the primary legs of Transfer Calipers? **(10)**

(b) Define pressure angle? Prove that $\delta = \tan\phi - \phi$, where ϕ is pressure angle and δ is involute function. **(10)**

(c) Determine the actual dimensions to be provided for a shaft and hole of 90 mm size for H_8e_9 type clearance fit. Size 90 mm falls in diameter steps of 80 mm and 100 mm. Standard tolerance factor, $i = 0.45\left(\sqrt[3]{D}\right) + 0.001D$ *microns*, where D is in *mm*. Value of tolerances for IT8 and IT9 grades are $25i$ and $40i$ respectively. Fundamental deviation for 'e' type shaft is $-11D^{0.41}$. Also design the GO and NO GO gauges. **(15)**

6. (a) State the Taylor's principle for the design of 'limit gauge'. What are the considerations for deciding the limits on the limit gauges? **(10)**

(b) What are the limitations of Sine bar? Show that, the sensitivity of autocollimator depends on the focal length of the objective lens. **(10)**

(c) Effective diameter of a screw thread can be measured using two wire method (Fig. 6(c)) as $E_d = T + P$, where T = Dimension under the wires and M = Dimension over the wires. **(15)**

(i) If the angle of thread is 45°, derive the expression for P value as a function of pitch, p and wire diameter, d that is $P = f(p,d)$.

(ii) Calculate the P value when pitch of the screw 3.55 mm and wire diameter 2.17 mm.

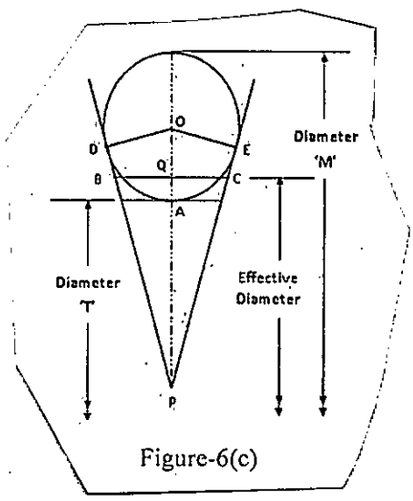

Figure-6(c)

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7. (a) State Abbe's principle of alignment. Briefly describe the indirect method of measurement. **(10)**

(b) What are the differences between primary and secondary texture? Briefly explain two methods of obtaining a numerical value of the texture from a given graphical record. **(10)**

(c) Determine the extreme distance, l between the two balls (diameter d_1 and d_2, $d_1<d_2$) such that the two straight edges be adjusted at an angle θ (Fig. 7(c)). **(15)**

Also show that, if $d_1 = d$ and $d_2 = 2d$ then, $l = \frac{d}{2}\left(\text{cosec}\,\theta/2 + 3\right)$.

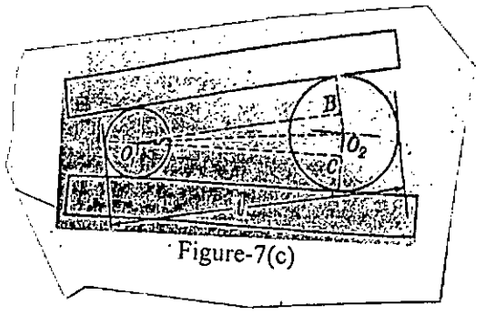

Figure-7(c)

8. (a) What is the main idea behind Crossby's 'quality is free' concept? **(10)**

(b) What are the main distinguishing characteristics of Total quality Management (TQM)? Mention the name of seven basic tools of TQM. **(10)**

(c) How does the concept of 'zero defect' is not economically beneficial according to Juran's model? Is it possible to achieve minimum cost at the point of 100% good quality? **(15)**

Table I: Factors for Control Charts

	Factor for Control Limits						
	$\bar{X}$ Chart			R Chart		S Chart	
n^*	A_1	A_2	d_2	D_3	D_4	c_4	n
2	3.760	1.880	1.128	0	3.267	0.7979	2
3	2.394	1.023	1.693	0	2.575	0.8862	3
4	1.880	.729	2.059	0	2.282	0.9213	4
5	1.596	.577	2.326	0	2.115	0.9400	5
6	1.410	.483	2.534	0	2.004	0.9515	6
7	1.277	.419	2.704	.076	1.924	0.9594	7
8	1.175	.373	2.847	.136	1.864	0.9650	8
9	1.094	.337	2.970	.184	1.816	0.9693	9
10	1.028	.308	3.078	.223	1.777	0.9727	10
11	.973	.285	3.173	.256	1.744	0.9754	11
12	.925	.266	3.258	.284	1.716	0.9776	12
13	.884	.249	3.336	.308	1.692	0.9794	13
14	.848	.235	3.407	.329	1.671	0.9810	14
15	.816	.223	3.472	.348	1.652	0.9823	15
16	.788	.212	3.532	.364	1.636	0.9835	16
17	.762	.203	3.588	.379	1.621	0.9845	17
18	.738	.194	3.640	.392	1.608	0.9854	18
19	.717	.187	3.689	.404	1.596	0.9862	19
20	.697	.180	3.735	.414	1.586	0.9869	20
21	.679	.173	3.778	.425	1.575	0.9876	21
22	.662	.167	3.819	.434	1.566	0.9882	22
23	.647	.162	3.858	.443	1.557	0.9887	23
24	.632	.157	3.895	.452	1.548	0.9892	24
25	.619	.153	3.931	.459	1.541	0.9896	25

Table II: Cumulative standard normal distribution

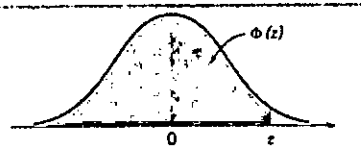

Table II Cumulative Standard Normal Distribution (*continued*)

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.500000	0.503989	0.507978	0.511967	0.515953	0.519939	0.532922	0.527903	0.531881	0.535856
0.1	0.539828	0.543795	0.547758	0.551717	0.555760	0.559618	0.563559	0.567495	0.571424	0.575345
0.2	0.579260	0.583166	0.587064	0.590954	0.594835	0.598706	0.602568	0.606420	0.610261	0.614092
0.3	0.617911	0.621719	0.625516	0.629300	0.633072	0.636831	0.640576	0.644309	0.648027	0.651732
0.4	0.655422	0.659097	0.662757	0.666402	0.670031	0.673645	0.677242	0.680822	0.684386	0.687933
0.5	0.691462	0.694974	0.698468	0.701944	0.705401	0.708840	0.712260	0.715661	0.719043	0.722405
0.6	0.725747	0.729069	0.732371	0.735653	0.738914	0.742154	0.745373	0.748571	0.751748	0.754903
0.7	0.758036	0.761148	0.764238	0.767305	0.770350	0.773373	0.776373	0.779350	0.782305	0.785236
0.8	0.788145	0.791030	0.793892	0.796731	0.799546	0.802338	0.805106	0.807850	0.810570	0.813267
0.9	0.815940	0.818589	0.821214	0.823815	0.826391	0.828944	0.831472	0.833977	0.836457	0.838913
1.0	0.841345	0.843752	0.846136	0.848495	0.850830	0.853141	0.855428	0.857690	0.859929	0.862143
1.1	0.864334	0.866500	0.868643	0.870762	0.872857	0.874928	0.876976	0.878999	0.881000	0.882977
1.2	0.884930	0.886860	0.888767	0.890651	0.892512	0.894350	0.896165	0.897958	0.899727	0.901475
1.3	0.903199	0.904902	0.906582	0.908241	0.909877	0.911492	0.913085	0.914657	0.916207	0.917736
1.4	0.919243	0.920730	0.922196	0.923641	0.925066	0.926471	0.927855	0.929219	0.930563	0.931888
1.5	0.933193	0.934478	0.935744	0.936992	0.938220	0.939429	0.940620	0.941792	0.942947	0.944083
1.6	0.945201	0.946301	0.947384	0.948449	0.949497	0.950529	0.951543	0.952540	0.953521	0.954486
1.7	0.955435	0.956367	0.957284	0.958185	0.959071	0.959941	0.960796	0.961636	0.962462	0.963273
1.8	0.964070	0.964852	0.965621	0.966375	0.967116	0.967843	0.968557	0.969258	0.969946	0.970621
1.9	0.971283	0.971933	0.972571	0.973197	0.973810	0.974412	0.975002	0.975581	0.976148	0.976705
2.0	0.977250	0.977784	0.978308	0.978822	0.979325	0.979818	0.980301	0.980774	0.981237	0.981691
2.1	0.982136	0.982571	0.982997	0.983414	0.983823	0.984222	0.984614	0.984997	0.985371	0.985738
2.2	0.986097	0.986447	0.986791	0.987126	0.987455	0.987776	0.988089	0.988396	0.988696	0.988989
2.3	0.989276	0.989556	0.989830	0.990097	0.990358	0.990613	0.990863	0.991106	0.991344	0.991576
2.4	0.991802	0.992024	0.992240	0.992451	0.992656	0.992857	0.993053	0.993244	0.993431	0.993613
2.5	0.993790	0.993963	0.994132	0.994297	0.994457	0.994614	0.994766	0.994915	0.995060	0.995201
2.6	0.995339	0.995473	0.995604	0.995731	0.995855	0.995975	0.996093	0.996207	0.996319	0.996427
2.7	0.996533	0.996636	0.996736	0.996833	0.996928	0.997020	0.997110	0.997197	0.997282	0.997365
2.8	0.997445	0.997523	0.997599	0.997673	0.997744	0.997814	0.997882	0.997948	0.998012	0.998074
2.9	0.998134	0.998193	0.998250	0.998305	0.998359	0.998411	0.998462	0.998511	0.998559	0.998605
3.0	0.998650	0.998694	0.998736	0.998777	0.998817	0.998856	0.998893	0.998930	0.998965	0.998999
3.1	0.999032	0.999065	0.999096	0.999126	0.999155	0.999184	0.999211	0.999238	0.999264	0.999289
3.2	0.999313	0.999336	0.999359	0.999381	0.999402	0.999423	0.999443	0.999462	0.999481	0.999499
3.3	0.999517	0.999533	0.999550	0.999566	0.999581	0.999596	0.999610	0.999624	0.999638	0.999650
3.4	0.999663	0.999675	0.999687	0.999698	0.999709	0.999720	0.999730	0.999740	0.999749	0.999758
3.5	0.999767	0.999776	0.999784	0.999792	0.999800	0.999807	0.999815	0.999821	0.999828	0.999835
3.6	0.999841	0.999847	0.999853	0.999858	0.999864	0.999869	0.999874	0.999879	0.999883	0.999888
3.7	0.999892	0.999896	0.999900	0.999904	0.999908	0.999912	0.999915	0.999918	0.999922	0.999925
3.8	0.999928	0.999931	0.999933	0.999936	0.999938	0.999941	0.999943	0.999946	0.999948	0.999950

L-2/T-1/ME **Date: 26/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **EEE 259** (Electrical and Electronic Technology)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

The symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Briefly describe, using necessary circuit diagrams, how the open-circuit test and short-circuit test of a transformer are performed. Mention on which side the respective tests are carried out. **(12)**

(b) Write, in short, the losses that normally occur in a real transformer. **(10)**

(c) A 14400/480-V, three-phase, Y-Δ connected transformer bank consists of three identical 100-kVa, 8314/480-V transformers. It is supplied with power directly from a large constant-voltage bus. In the short-circuit test, the recorded values on the high-voltage side for one of these transformers are: **(24⅔)**

$$V_{SC} = 510\,V$$
$$I_{SC} = 12.6\,A$$
$$P_{SC} = 3000\,W$$

(i) If this bank delivers a rated load at 0.8 power factor lagging and rated voltage, what is the line-to-line voltage on the primary of the transformer bank?

(ii) What is the voltage regulation under these conditions?

(iii) Given that overall core losses in the transformer bank are 10 kW, what is the efficiency of the transformer at rated load?

2. (a) What is synchronous speed? Draw the torque-speed characteristic curve of an induction motor and a synchronous motor, labeling the pull-out torque and synchronous speed. **(15)**

(b) Derive the Thevenin equivalent voltage V_{TH} and impedance Z_{TH} of the input side of an induction motor. Also show that maximum torque of an induction motor is given by, **(16)**

$$\tau_{max} = \frac{3V_{TH}^2}{2\omega_{sync}\left[R_{TH} + \sqrt{R_{TH}^2 + (X_{TH} + X_2)^2}\right]}$$

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(c) A 230-V, 75 hp, 60-Hz, three phase four pole wye-connected wound-rotor induction motor has the following impedances in ohms per phase referred to the stator circuit: **(15⅔)**

$R_1 = 0.058\Omega$ $R_2 = 0.0140\Omega$ $X_M = 18\Omega$

$X_1 = 0.32\Omega$ $X_2 = 0.386\Omega$

(i) What is the maximum torque of this motor? At what slip does it occur?

(ii) If the rotor resistance is double, what is the speed at which the maximum torque now occurs?

(iii) Draw the torque-speed characteristics of this motor, clearly showing the change due to increase in the rotor resistance.

3. (a) What are the conditions for parallel operation of AC generators? **(10⅔)**

(b) With necessary phasor diagram, discuss the effect of changing field resistance on a synchronous generator operating in parallel with large power systems. **(15)**

(c) Two identical 2.5=MVA, 1200-V 0.8-PF-lagging, 60-Hz, three-phase synchronous generators are connected in parallel to supply a load as shown in Fig. for Q3(c). The prime movers of the two generators have different speed drop characteristics. When the field currents of the two generators are equal, one delivers 1200 A at 0.9 PF lagging, while the other delivers 900 A at 0.75 PF lagging. **(21)**

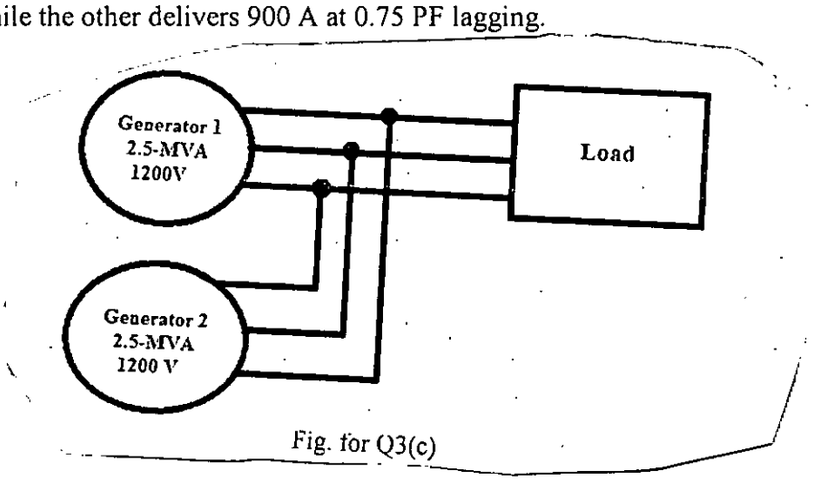

Fig. for Q3(c)

(i) What are the real power and reactive power supplied by each generator to the load?

(ii) Draw the terminal voltage versus reactive power graph for this system, clearly labeling the reactive power supplied by each generator.

(iii) What is the overall power factor of the load?

(iv) In what reaction must the field current on each generator be adjusted in order for them to operate at the same power factor?

4. (a) With the help of phasor diagram, show that the total real power measured by two-wattmeter method is given by the sum of the two wattmeter readings. Also write down the formula for reactive power measured using the same method. **(20)**

(b) Explain the reasons for voltage build up failure in a dc shunt generator. **(13⅔)**

(c) Describe the methods of terminal voltage control in a separately excited dc generator. **(13)**

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SECTION – B

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

5. (a) Design a circuit that has the transfer characteristics as shown in Fig. For Q. 5(a). Assume that you have ideal diodes, resistors and dc voltage source. **(20⅔)**

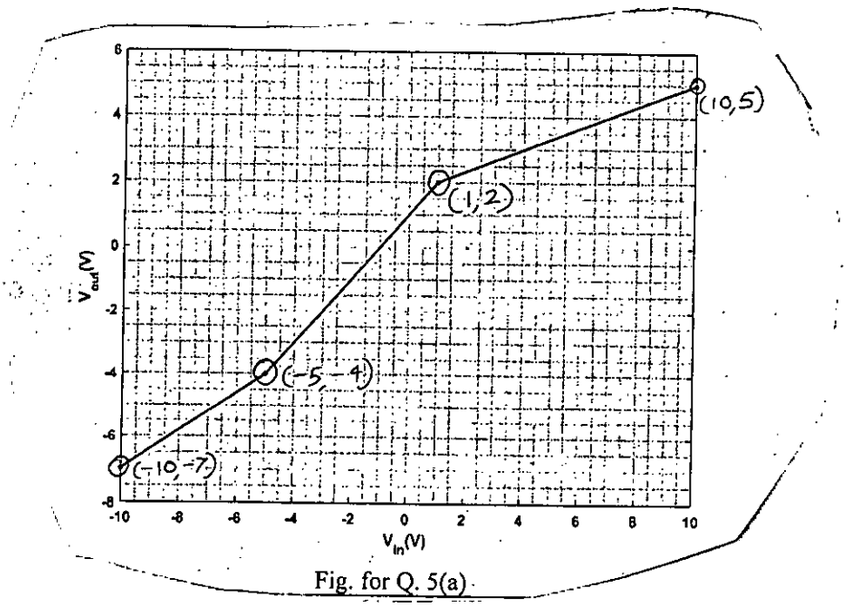

Fig. for Q. 5(a)

(b) Explain the operating principle of a thyristor using two transistor model. **(14)**

(b). For a class B amplifier providing a 20 V peak signal to a 16 Ω load (speaker) and a power supply of V_{CC} = 30 V, determine the input power, output power, and circuit efficiency. **(12)**

6. (a) The 6.8 V zener diode in the circuit of Fig. for Q. 6(a) is specified to have V_z = 6.8 V at I_z = 5 mA, r_z = 20 Ω, and I_{zk} = 0.2 mA. The supply voltage V^+ is nominally 10 V but can vary by ±1 V . **(23)**

   (i) Find V_0 with no load and V^+ at its nominal value

   (ii) Find **line regulation** (change in V_0 for ±1 V change in V^+)

   (iii) Find **load regulation** (change in V_0 from connecting R_L that draws a current I_L = 1 mA)

   (iv) Find change in V_0 when R_L = 2 KΩ

   (v) Find minimum value of R_L for which diode still operates in breakdown region.

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Contd... Q. No. 6(a)

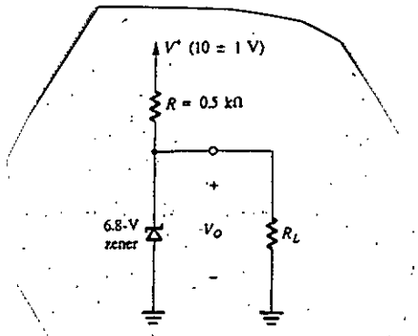

Fig. for Q. 6(a)

(b) For the emitter follower in Fig. for Q. 6(b), the signal source is directly coupled to the transistor base. If the dc component of v_{sig} is zero, find the dc emitter current. Assume β = 100 and Si transistor. Neglecting r_0, find R_{in}, the voltage gain $\frac{v_0}{v_{sig}}$, the current $\frac{i_0}{i_i}$, and the output resistance R_{out}. **(23⅔)**

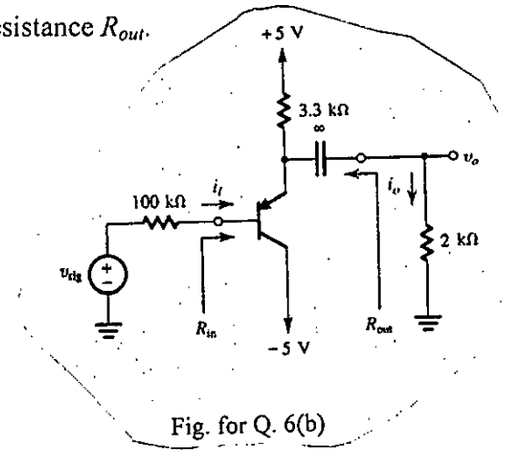

Fig. for Q. 6(b)

7. (a) In the circuit shown in the Fig. for Q. 7(a), the Si transistor has $\beta = 50$. Find the values of V_B, V_C and V_E. If R_B is raised to 100 $K\Omega$ what are the new values of V_B, V_C and V_E? If R_B = 100 $K\Omega$, what value of β would return the voltages to the value first calculated? **(20⅔)**

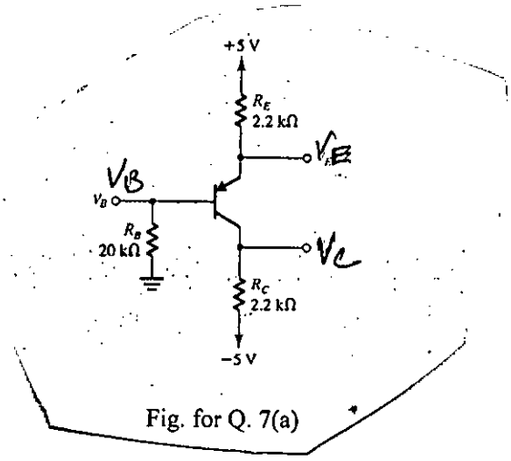

Fig. for Q. 7(a)

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Contd... Q. No. 7

(b) For the circuit shown in the Fig. for Q. 7(b) the transistor is characterized by $|V_{tp}| = 2V$, $\frac{k'_p W}{L} = \frac{1mA}{V^2}$ and $\lambda = 0$. Find the labeled voltages V_4 and V_5. **(13)**

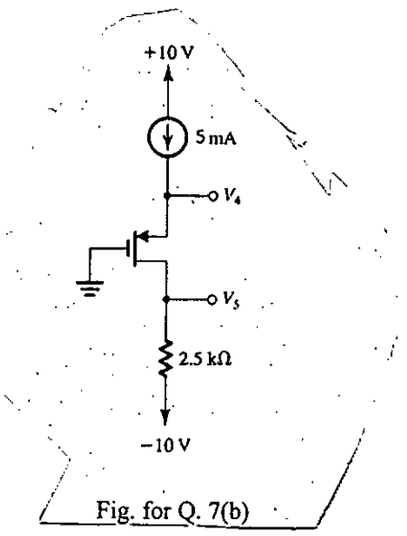

Fig. for Q. 7(b)

(c) Derive the expression of gauge factor of a strain gauge. **(13)**

8. (a) What types of losses are present in a real DC machine? Draw the power flow diagram in DC machines. **(10)**

(b) With neat sketches describe the problems with commutation of a real dc machine. **(24⅔)**

(c) A 20 hp, 220 V, 1500 r.p.m. DC shunt motor with compensating winding has a armature resistance of 0.01 Ω. It's no-load speed is 1500 r.p.m. The field circuit is composed of an internal resistance of 20 Ω and an adjustable resistance which can be varied between 0–150 Ω. There are 1000 turns per pole on the field windings. Calculate speed of the motor when input current is 75 A, 125 A and 175 A. (Assume R_{adj} = 75 Ω). Also plot the torque-speed characteristics of the motor using the calculated values. **(12)**

L-2/T-1/ME **Date: 03/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **HUM 303** (Principles of Accounting)

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) What are the elements of financial statements? Explain with example. **(10)**

(b) Herrington Hotel has the following transactions on May 2018. **(25)**

May-1	The owner Investment Tk. 10,00,000 cash.
May-2	Advertise on account Tk. 5,000.
May-5	Purchase supplies for cash Tk. 60,000.
May-10	Purchase office equipment for Tk. 2,50,000, paying Tk. 50,000 in cash and remaining on account.
May-12	Service provided on account Tk. 10,000.
May-15	Withdraw cash for personal use Tk. 10,000.
May-18	Salary for the month paid in cash Tk. 25,000.
May-20	Paid balance due for advertisement for May-2 transaction.
May-22	Cash received from customer for May-12 transaction.
May-24	Provide services for cash Tk. 20,000.

Required:

(i) Prepare necessary journal entries for May 2018.

(ii) Prepare a cash ledger account.

2. (a) What are the limitations of trial balance? **(4)**

(b) Following are the account balances of Legend Computer Service Company for the Year on 30th June 2018. **(19)**

Account Title	Amount (Tk.)	Account Title	Amount (Tk.)
Cost of Computer	20,00,000	Bad Debts	50,000
Sale of Computer	34,00,000	Prepaid Insurance	50,000
Service fees received	3,00,000	Office equipment	60,000
Salaries to engineers	2,00,000	Salary to Staff	85,000
Advertisement expense	50,000	Bank Balance	4,55,000
Office Rent	60,000	Unpaid Salaries	5,000
Maintenance expense	1,30,000	Accounting Receivable	6,00,000
Account Payable	80,000	Beginning Inventories	4,00,000
Tax payable	5,000	Furniture	2,50,000
Capital	6,00,000		

Required: Prepare a trial balance on 30th June 2018.

Contd P/2

HUM 303/ME

Contd... Q. No. 2

(c) Selected comparative data for Betax Product company are presented below: **(12)**

	2018 (Tk.)	2017 (Tk.)
Net Sales (all in credit)	7,50,000	7,20,000
Cost of Goods Sold	4,80,000	4,40,000
Interest Expense	7,000	5,000
Net Income	45,000	42,000
Account Receivable	1,20,000	1,00,000
Inventory	85,000	75,000
Total Assets	5,80,000	5,00,000
Total Shareholders' Equity	4,30,000	3,25,000

Required: Compute the following ratios for 2018.

(i) Profit Margin

(ii) Asset Turnover

(iii) Return on Asset

(iv) Return on Shareholders' Equity

(v) Inventory Turnover

(vi) Accounts Receivable Turnover.

3. (a) What is accrual basis of Accounting? How is it related to adjusting entry? **(5)**

(b) The trial balance of Samuel Electronics at January 31, 2018 is given below: **(30)**

Samuel Electronics Trial Balance January 31, 2018		
Account Title	Debit (tk.)	Credit (tk.)
Cash	12,800	
Supplies	2,500	
Prepaid Insurance	3,000	
Office Equipment	5,000	
Note Payable		5,000
Account Payable		2,500
Unearned Revenue		1,200
Capital		10,000
Drawings	500	
Service Revenue		10,000
Salary Expense	4,000	
Utility Expense	900	
Total	28,700	28,700

Contd P/3

HUM 303/ME

Contd... Q. No. 3(b)

Analysis reveals the following additional data:

* Supplies on hand at January 31, Tk. 1,200.
* Insurance policy is for two years.
* Depreciation Tk. 200 for each month.
* Unearned revenue is still unearned Tk. 800.
* Interest accrued at January Tk. 200.
* Service provided but not received Tk. 1,200.

Required:

(i) Prepare adjusting entries for January 31st, 2018.

(ii) Prepare adjusted trial balance as on January 31st, 2018.

4. The following is the trial balance of Nissan Company as on December 31st, 2018. **(35)**

Nissan Company Trial Balance December 31st 2018		
Account Title	Debit (tk.)	Credit (tk.)
Sales Revenue		50,000
Merchandise Inventory (01.01.18)	6,000	
Purchase	24,000	
Purchase Return		1,000
Sales discounts	2,500	
Accounts Receivable	20,000	
Accounts Payable		14,000
Capital		40,000
Drawings	10,000	
Salaries	8,000	
Supplies	3,000	
Delivery Van	20,000	
Cash	9,300	
Prepaid Insurance	2,200	
Total	1,05,000	1,05,000

Other Information:

(i) Supplies used Tk. 1,200.

(ii) Depreciation on delivery van is Tk. 2,000.

(iii) Merchandise Inventory (31.12.18) was Tk. 5,500.

(iv) Tk. 2,500 of accounts receivable was uncollectible.

(v) Salaries were accrued Tk. 4,000.

(vi) Insurance expense was Tk. 2,000.

Required:

(a) prepare a classified Income Statement and Owners Equity Statement.

(b) Prepare a classified Balance Sheet as on 31st December 2018.

Contd P/4

HUM 303/ME

SECTION – B

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

5. (a) Define management accounting. Distinguish between financial accounting and management account. **(8)**

(b) Following are the particulars taken from the books of Dhaka Manufacturing Company for the year ended 31 December 2018: **(27)**

Inventories	1 January	31 December
Raw Materials	Tk. 60,000	Tk. 70,000
Work-In-Process	40,000	30,000
Finished Goods	50,000	80,000
Raw Materials Purchased	Tk. 150,000	
Purchase Returns	10,000	
Sales Revenue	650,000	
Sales Returns	30,000	
Sales Discounts	10,000	
Direct Labor	150,000	
Indirect Labor	20,000	
Depreciation (70% factory, 30% administrative)	50,000	
Freight Out	10,000	
Sales Commission	40,000	
Sales Salaries	30,000	
Factory Rent	30,000	
Factory Insurance	20,000	
Marketing Expenses	20,000	
Advertising Expenses	25,000	
Other Factory Expenses	15,000	
Factory Utilities	10,000	
Supervisor's Salary	30,000	
Office Supplies	10,000	

Required:

Prepare a cost of Goods Sold Statement and an Income Statement for the year ended 31 December 2018.

6. (a) Explain assumptions of break-even point. **(5)**

(b) Taranagar Company is the exclusive distributor for an automotive product that sells for Tk. 50,000 per unit and has a variable cost ratio of 60%. The company's fixed expenses are Tk. 600,000 per month. **(15)**

Contd P/5

HUM 303/ME

Contd... Q. No. 6(b)

Required:

(i) What is the annual break-even point in units and sales value?

(ii) What sales level in units and in sales value is required to earn an annual profit of Tk. 2,000,000?

(iii) Assume that currently, the company is able to sell 400 units annually. What is the margin of safety in both sales value and percentage form?

(c) Keraniganj Company manufacturers and sells one product. The following information pertains to each of the company's first two years of operations: **(15)**

Variable costs per unit:	
Manufacturing:	
Direct materials	Tk. 25
Direct labor	Tk. 15
Variable manufacturing overhead	Tk. 5
Variable selling and administrative expense	Tk. 2
Fixed costs per year:	
Fixed manufacturing overhead	Tk. 250,000
Fixed selling and administrative expenses	Tk. 80,000

During its first year of operations, Keraniganj produced 50,000 units and sold 40,000 units. During its second year of operations, it produced 40,000 units and sold 50,000 units. The selling price of the company's product is Tk. 60 per unit.

Required:

Prepare an income statement for Year 1 and Year 2 under variable costing.

7. (a) What do you mean by job-order costing system? How does it differ from process costing? **(5)**

(b) Barilgaon Company uses job-order costing. It starts a job. The job requires direct materials of Tk. 750,000. It applies overhead cost to jobs on the basis of direct labor cost. For the current year, the company estimates that it will incur Tk. 300,000 in direct labor cost and Tk. 150,000 of manufacturing overhead. During the year, Tk. 350,000 of direct labor costs was incurred. Actual overhead costs incurred were: **(10)**

Indirect materials expense	Tk. 20,000
Insurance expense	10,000
Depreciation expense	30,000
Indirect labor expense	50,000
Utilities expense	25,000
Rent expense	30,000

Required:

(i) Compute the company's predetermined overhead rate.

(ii) Compute the cost of the job.

(iii) Compute the amount of over-or under-applied overhead.

Contd P/6

HUM 303/ME

Contd... Q. No. 7

(c) The Kalatia Company is a furniture manufacturer with two departments: molding and finishing. The company uses the weighted-average method of process costing. In June 2018, the following data were recorded for the molding department: **(20)**

Units in beginning inventory (25% complete)	12,500
Units started	87,500
Units completed	75,000
Units in ending inventory (70% complete)	25,000
Cost in beginning work in process:	
Direct materials	Tk. 520,000
Conversion costs	Tk. 52,500
Total costs added during current period:	
Direct materials	Tk. 880,000
Conversion costs	Tk. 410,000

Conversion costs are added evenly during the process. Direct material costs are added when production is 20% complete.

Required:

For June, summarize total costs to account for and assign these costs to units transferred out and to units in ending work in process.

8. (a) Troy Engines, Ltd., manufactures a variety of engines for use in heavy equipment. The company has always produced all the necessary parts for its engines, including all the carburetors. An outside supplier has offered to sell one type of carburetor to Troy Engines, Ltd., for a cost of $35 per unit. To evaluate this offer, Troy Engines, Ltd., has gathered the following information relating to its own cost of producing the carburetor internally: **(20)**

	Per Unit	15,000 Units Per Year
Direct materials	$14	$210,000
Direct labor	10	150,000
Variable manufacturing overhead	3	45,000
Fixed manufacturing overhead, traceable	6*	90,000
Fixed manufacturing overhead allocated	9	135,000
Total cost	$42	$630,000

*One-third supervisory salaries; two-thirds depreciation of special equipment

Required:

(i) If the company has no alternative use for the facilities that are now being used to produce the carburetors, should the outside supplier's offer be accepted? Show all computations.

(ii) Suppose that if the carburetors were purchased, Troy Engines, Ltd., could use the freed capacity to launch a new product. The segment margin of the new product would be $150,000 per year. Should Troy Engines, Ltd. accept the offer to buy the carburetors for $35 per unit? Show all computations.

Contd P/7

HUM 303/ME

Contd... Q. No. 8

(b) The Regal Cycle Company manufactures three types of bicycles— a dirt bike, a mountain bike, and a racing bike. Data on sales and expenses for the past quarter follow: **(15)**

	Total	Dirt Bikes	Mountain Bikes	Racing Bikes
Sales	$300,000	$90,000	$150,000	$60,000
Variable manufacturing and selling expenses	120,000	27,000	60,000	33,000
Contribution margin	180,000	63,000	90,000	27,000
Fixed expenses:				
Advertising, traceable	30,000	10,000	14,000	6,000
Depreciation of special equipment	23,000	6,000	9,000	8,000
Salaries of product-line managers	35,000	12,000	13,000	10,000
Allocated common fixed expenses*	60,000	18,000	30,000	12,000
Total fixed expenses	148,000	46,000	66,000	36,000
Net operating income (loss)	$ 32,000	$17,000	$ 24,000	$ (9,000)

*Allocated on the basis of sales dollars.

Management is concerned about the continued losses shown by the racing bikes and wants a recommendation as to whether the line should be discontinued. The special equipment used to produce racking bike has no resale value and does not wear out.

Required:

Should production and sale of the racing bikes be discontinued? Explain. Show computations to support your answer.

L-2/T-1/ME **Date: 20/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **MATH 261** (Vector Calculus, Matrices, Laplace Transform and Series Solution)

Full Marks: 280 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) Show that every square matrix can be expressed in one and only one way as the sum of a symmetric and a skew-symmetric matrix. **(15)**

(b) Find adj(adj A), where $A=\begin{bmatrix}1 & 0 & 2\\ 1 & 1 & 0\\ 1 & 2 & 3\end{bmatrix}$ **(16⅔)**

(c) Reduce the quadratic form $q = x_1^2 + 2x_2^2 - 2x_3^2 + 4x_1x_2 + 6x_1x_3$ to canonical form and find the rank, index and signature of the form. **(15)**

2. (a) Solve the following system of linear equations after reducing the augmented matrix to its reduced row-echelon form: **(23⅔)**

$$x_1 + x_2 + x_3 + x_4 - 4 = 0$$
$$2x_1 - x_2 - x_3 + 3x_4 - 6 = 0$$
$$3x_1 + 4x_2 - 5x_3 + 6x_4 + 11 = 0$$
$$7x_1 - 5x_2 + 7x_3 + x_4 - 46 = 0$$

(b) Find the eigenvalues and corresponding eigenvectors of the matrix **(23)**

$$A=\begin{bmatrix}1 & 0 & -1\\ 1 & 2 & 1\\ 2 & 2 & 3\end{bmatrix}$$

3. (a) If $\bar{r} = (a\cos t)\hat{i} + (a\sin t)\hat{j} + (at)\tan\alpha\,\hat{k}$, find $\frac{d}{dt}\left[\bar{r}\,\frac{d\bar{r}}{dt}\,\frac{d^2\bar{r}}{dt^2}\right]$. **(15)**

(b) A fluid motion is given by $\bar{v} = (y+z)\hat{i} + (z+x)\hat{j} + (x+y)\hat{k}$. Is the motion irrotational? If so, find the velocity potential. **(16⅔)**

(c) If a force $\bar{F} = 2x^2y\hat{i} + 3xy\hat{j}$ displaces a particle in the xy-plane from (0, 0) to (1, 4) along a curve $y = 4x^2$, find the work done. **(15)**

4. (a) Use Green's theorem to evaluate the integral $\oint_C [(xy + y^2)dx + x^2dy]$, where C is the closed curve of the region bounded by $y = x$ and $y = x^2$. **(16)**

(b) State Stokes' theorem and verify theorem for the vector function **(30⅔)**

$$\bar{F} = (x+y)\hat{i} + (2x-z)\hat{j} + (y+z)\hat{k}$$

taken over the triangle ABC cuts from the plane $3x+2y+z=6$ by the co-ordinate planes.

Contd P/2

MATH 261

SECTION – B

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

5. (a) Solve in series, by the method of Fröbenius, the following differential equation: **(36⅔)**

$$x^2y''(x)+(x+x^2)y'(x)+(x-9)y(x)=0$$

(b) Show that $J_{-\frac{1}{2}}(x)=\sqrt{2/\pi x}\cos x$. **(10)**

6. (a) Show that $x^2J_n''(x)=(n^2-n-x^2)J_n(x)+xJ_{n+1}(x)$. **(16⅔)**

(b) Show that $\frac{d}{dx}[xJ_n(x)J_{n+1}(x)]=x[J_n^2(x)-J^2{}_{n+1}(x)]$. **(16)**

(c) Show that $xP_n'(x)-P_{n-1}'(x)=nP_n(x)$. **(14)**

7. (a) Show that $P_n(x)=\frac{1}{2^n\lfloor n+1}\frac{d^n}{dx^n}(x^2-1)^n$ **(15)**

(b) Let $f(t)=\begin{cases}3t, & 0<t<2\\ 6, & 2<t<4\end{cases}$ where $f(t)$ has period 4. Find $L\{f(t)\}$ and draw the graph. **(16⅔)**

(c) State convolution theorem and using this theorem, find **(15)**

$$L^{-1}\left\{\frac{1}{s^2(s+1)^2}\right\}$$

8. (a) Solve the integral equation (using Laplace Transform): **(15)**

$$y(t)=1+\int_0^t y(u)\cos(t-u)du$$

(b) Find the inverse Laplace Transform of $\frac{2s^3+10s^2+8s+40}{s^2(s^2+9)}$. **(15)**

(c) Solve (using Laplace Transform): $ty''(t)+y'(t)+4ty(t)=0$ with $y(0)=3$, $y'(0)=0$. **(16⅔)**

Self-study/ME Date : 30/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations

Sub : **ME 249** (Engineering Mechanics II)

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**.

1. (a) A 30-g bullet as shown in Fig. 1(a) is fired with a horizontal velocity of 450 m/s and becomes embedded in block *B* which has a mass of 3 kg. After the impact block *B* slides on 30-kg carrier *C* until it impacts the end of the carrier. Knowing the impact between B and C is perfectly plastic and the coefficient of kinetic friction between *B* and *C* is 0.2, determine (i) the velocity of the bullet and *B* after the first impact, (ii) the final velocity of the carrier. **(17)**

   (b) An 18-kg cannonball and a 12-kg cannonball are chained together as shown in Fig. 1(b) and fired horizontally with a velocity of 165 m/s from the top of a 15-m wall. The chain breaks during the flight of the cannonballs and the 12-kg cannonball strikes the ground at t = 1.5 s, at a distance of 240 m from the foot of the wall, and 7 m to the right of the line of fire. Determine the position of the other cannonball at that instant. Neglect the resistance of the air. **(18)**

2. (a) Collar A as shown in Fig. 2(a) moves upward with a constant velocity of 1.2 m/s. At the instant shown when $\theta = 25°$, using the method of relative velocity determine (i) the angular velocity of rod *AB*, (ii) the velocity of collar *B*. **(17)**

   (b) Rod *BDE* is partially guided by a roller at *D* which moves in a vertical track as shown in Fig. 2(b). Knowing that at the instant shown the angular velocity of crank *AB* is 5 rad/s clockwise and that $\beta = 25°$, determine (i) the angular velocity of the rod, (ii) the velocity of Point *D*. **(18)**

3. (a) A uniform rod *BC* of mass 4 kg is connected to a collar *A* by a 250-mm cord *AB* as shown in Fig. 3(a). Neglecting the mass of the collar and cord, determine (i) the smallest constant acceleration $\mathbf{a}_A$ for which the cord and the rod lie in a straight line, (ii) the corresponding tension in the cord. **(17)**

Contd P/2

ME 249

Contd ... Q. No. 3

(b) A uniform slender rod of length L = 900 mm and mass m = 4 kg is suspended from a hinge at C as shown in Fig. 3(b). A horizontal force **P** of magnitude 75 N is applied at end B. Knowing that r = 225 mm, determine (i) the angular acceleration of the rod, (ii) the components of the reaction at C. **(18)**

4. Knowing that at the instant shown in Fig. 4 the rod attached at A has an angular velocity of 5 rad/s counterclockwise and an angular acceleration of 2 rad/s^2 clockwise, determine the angular velocity and the angular acceleration of the rod attached at B. **(35)**

SECTION – B

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

All the notations has their usual meaning.

5. (a) Pin C is attached to rod BC shown in Figure for Ques. No. 5(a) and slides freely in the slot of rod OA which rotates at the constant rate ω. At the instant when B = 60°, determine (i) $\dot{r}$ and $\dot{\theta}$ (ii) $\ddot{r}$ and $\ddot{\theta}$. Express your answers in terms of d and ω. **(17)**

(b) The system shown in figure for Ques. No. 5(b) starts from rest and each component moves with a constant acceleration. If the relative acceleration of block C with respect to collar B is 60 mm/sec^2 upward and the relative acceleration of block D with respect to block A is 110 mm/sec^2 downward, determine (i) the velocity of block C after 3 sec. (ii) the change in position of block D after 5 sec. **(18)**

6. (a) A small block B shown in figure for ques. No. 6(a) fits inside of slot cut in arm OA which rotates in a vertical plane at a constant rate. The block remains in contact with the end of the slot closest to A and its speed is 1.4 m/s for $0 \leq \theta \leq 150°$. Knowing that the block begins to slide when $\theta = 150°$, determine the coefficient of static friction between the block and the slot. **(18)**

(b) Rod OA shown in figure for Ques. No. 6(b) oscillates about O in a horizontal plane. The motion of the 2.5 kg collar B is defined by the relation $r = 250/(t+4)$ and $\theta = (2/\pi)\sin\pi t$, where r is expressed in millimeters, t in seconds and θ in radians. Determine the radial and transverse components of the force exerted on the collar when (i) t = 1 s, (b) t = 6 s. **(17)**

Contd P/3

ME 249

7. (a) A baseball player hits a 160-g baseball with an initial velocity of 40 m/s at an angle of 40° with the horizontal as shown in figure for Ques. No. 7(a). Determine (i) the kinetic energy of the ball immediately after it is hit (ii) the kinetic energy of the ball when it reaches its maximum height. (iii) the maximum height above the ground reached by the ball. **(17)**

   (b) A 2-kg collar is attached to a spring as shown in figure for Ques. No. 7(b) and slides without friction in a vertical plane along the curved rod *ABC*. The spring is undeformed when the collar is at *C* and its constant is 600 N/m. If the collar is released at A with no initial velocity, determine its velocity (i) as it passes through *B*, (ii) as it reaches C. **(18)**

8. (a) One of the requirements for tennis balls to be used in official competition is that, when dropped onto a rigid surface from a height of 2.5 m, the height of the first bounce of the ball must be in the range of $1.325 \text{ m} \leq h \leq 1.45 \text{ m}$. Determine the range of the coefficient of restitution of the tennis balls satisfying this requirement. **(15)**

   (b) A 25-g steel-jacketed bullet is fired horizontally with a velocity of 600 m/s and ricochets off a steel plate as shown in figure for Ques. No. 8(b) along the path CD with a velocity of 400 m/s. Knowing that the bullet leaves a 10-mm scratch on the plate and assuming that its average speed is 500 m/s while it is in contact with the plate, determine the magnitude and direction of the average impulsive force exerted by the bullet on the plate. **(20)**

ME 249

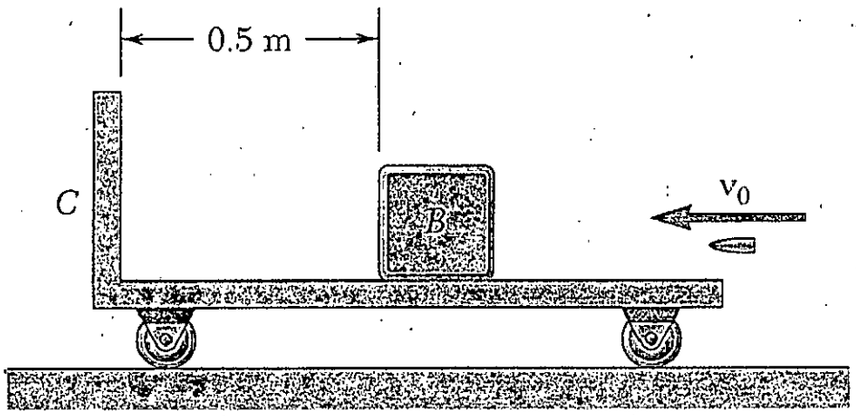

Fig. 1(a)

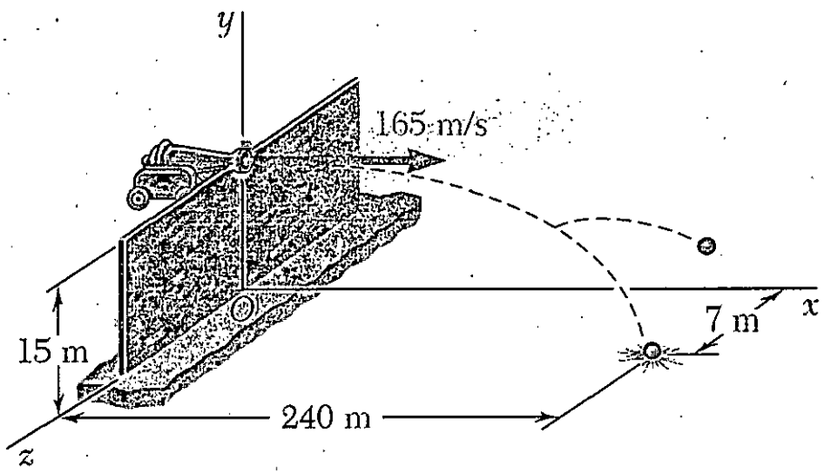

Fig. 1 (b)

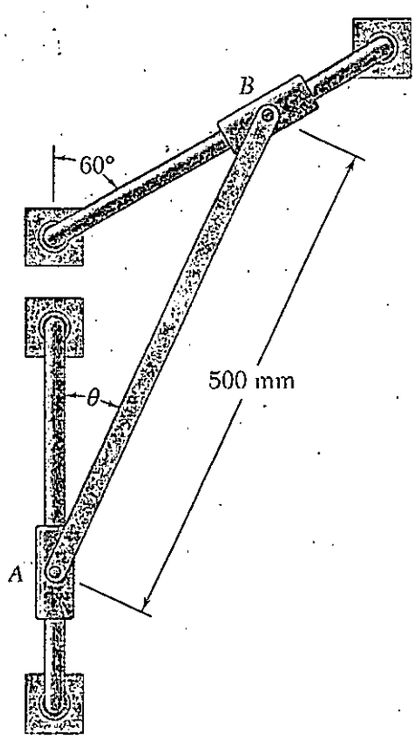

Fig.2 (a)

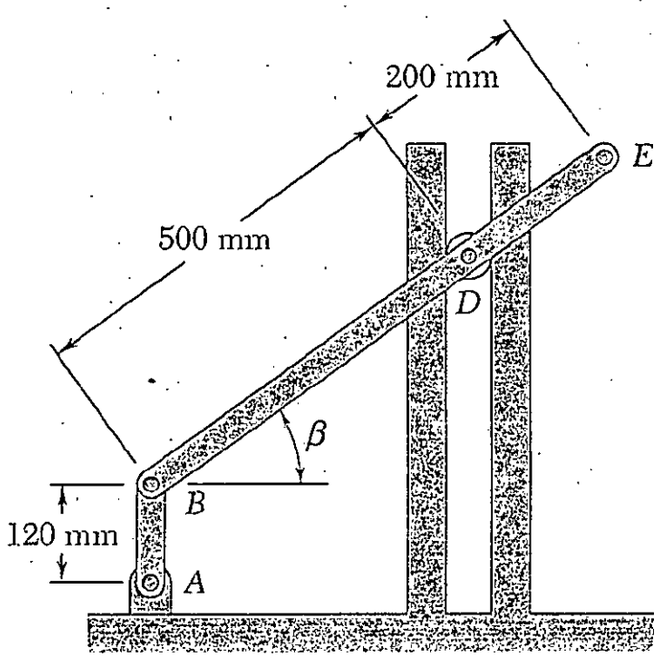

Fig. 2(b)

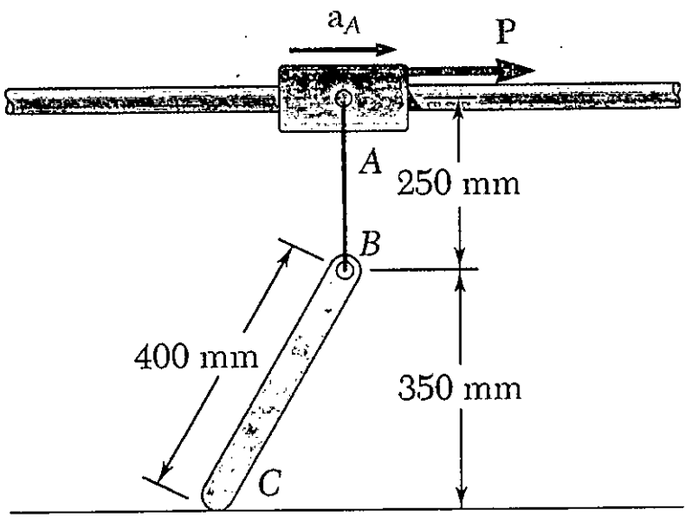

Fig. 3(a)

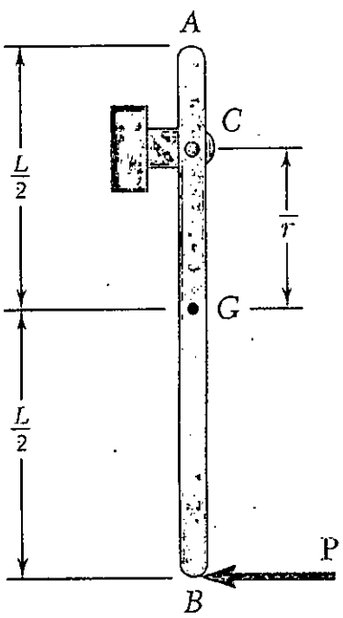

Fig. 3(b)

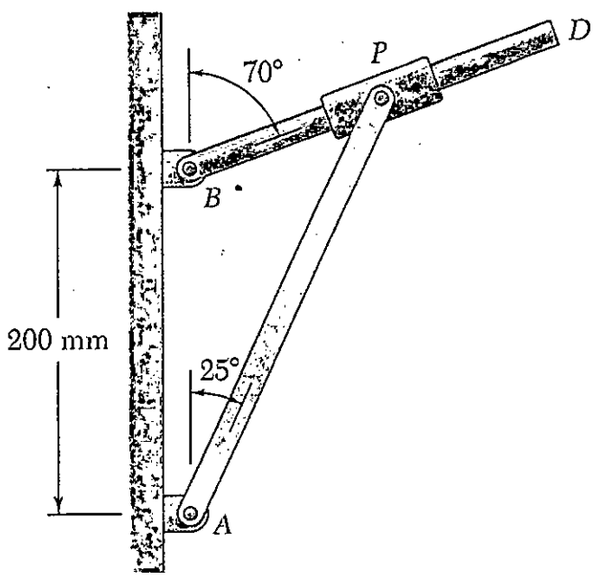

Fig. 4

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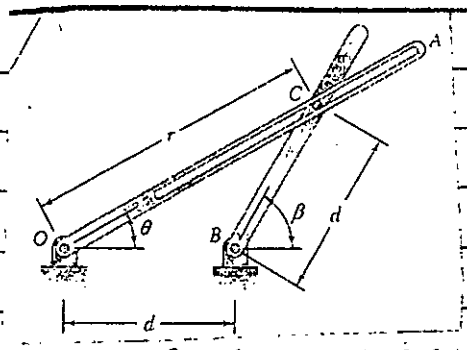
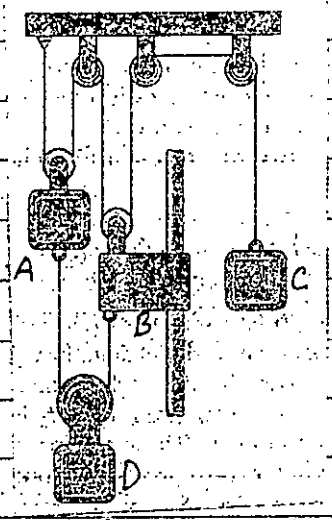


Figure for Ques. No. 5 (a)



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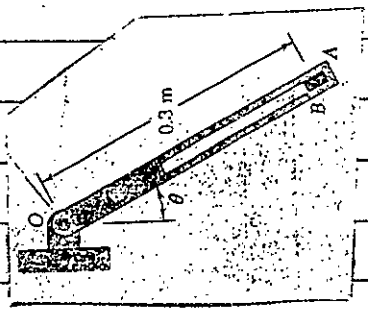
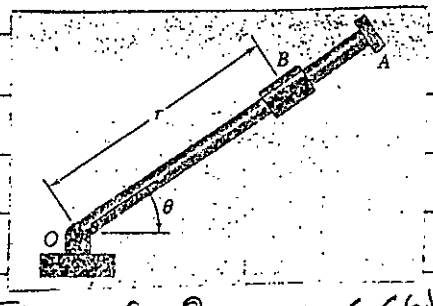


Figure for Ques. No. 6 (a)



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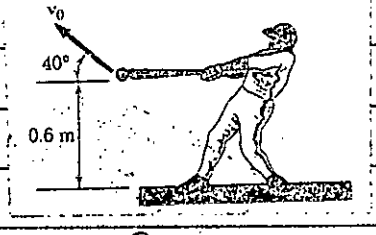
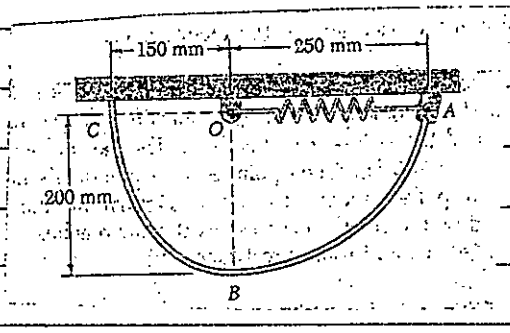


Figure for Ques. No. 7 (a)



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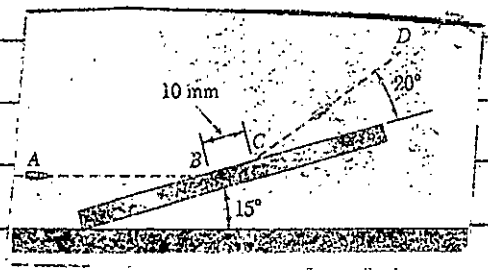

Figure for Ques. No. 8 (b)

L-2/T-1/ME Date : 09/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **ME 247** (Engineering Mechanics - I)

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) A sailor is being rescued using a boatswain's chair that is suspended from a pulley that can roll freely on the support cable ACB and is pulled at a constant speed by cable CD as shown in Fig. 1(a). Knowing that $\alpha = 30°$ and $\beta = 10°$ and that the combined weight of the boatswain's chair and the sailor is 900 N, determine the tension (i) in the support cable ACB, (ii) in the traction cable CD. **(15)**

   (b) A container of weight W is suspended from ring A as shown in Fig. 1(b). Cable BAC passes through the ring and is attached to fixed supports at B and C. Two forces $\bar{P}=P\bar{i}$ and $\bar{Q}=Q\bar{k}$ are applied to the ring to maintain the container in the position shown. Knowing that W = 376 N, determine P and Q. (Hint: The tension is the same in both potions of cable BAC.) **(20)**

2. (a) A plate OBCD is held by two cables AB and AC in the position shown in Fig. 2(a). Knowing that the tension in cable that AC is 1065 N, determine the moment about the diagonal DB of the force exerted on the plate at C. **(15)**

   (b) Four forces act on a 700×375-mm plate as shown in Fig. 2(b). (i) Find the resultant of these forces. (ii) Locate the two points where the time of action of the resultant intersects the edge of the plate. **(20)**

3. (a) A rod is supported at A and B and acted upon by a force at C as shown in Fig. 3(a). Determine the reactions at A and B when $\beta = 50°$. **(15)**

   (b) The 6-m pole ABC is acted upon by a 455-N force as shown in Fig. 3(b). The pole is held by a ball-and-socket joint A and by two cables BD and BE. Determine the tension in each cable and the reaction at A. **(20)**

4. (a) The mechanism shown in Fig. 4(a) is acted upon by the force P; derive an expression for the magnitude of the force Q required to maintain equilibrium. Solve the problem by principle of virtual work. **(15)**

   (b) Cable ACB supports a load uniformly distributed along the horizontal as shown in Fig. 4(b). The lowest point C is located 9 m to the right of A. Determine (i) the vertical distance a, (ii) the length of the cable, (iii) the components of the reaction at A. **(20)**

Contd P/2

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SECTION – B

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

5. (a) For the shaded area under the parabolic curve shown in Figure 5(a), determine the location of the centroid. **(17)**

   (b) An automatic valve consists of a 10m by 10 m square plate that is pivoted about a horizontal axis through A (as shown in Figure 5(b)). If the valve is to open when the depth of water is d = 15 m, determine from the bottom of the valve to the pivot A. **(18)**

6. (a) Using the method of sections, determine the force in members CD and DF of the truss as shown in Figure 6 (a). **(17)**

   (b) For the frame structure shown in Figure 6(b), determine the components of the reactions at A and E if a 750 N force directed vertically downward is applied at B. **(18)**

7. (a) Knowing that the coefficient of static friction between the collar and the rod is 0.35, determine the range of values of P for which equilibrium is maintained when $\theta = 50°$ and M = 20 N-m? **(17)**

   (b) A loaded railroad car has a mass of 30 Mg and is supported by eight 800 mm diameter wheels with 125 mm diameter axies. Knowing that the coefficients of friction are μ_s = 0.020 and μ_k = 0.015, determine the horizontal force required (i) to start the car moving, (ii) to keep the car moving at a constant speed. Neglect rolling resistance between the wheels and the rails. **(18)**

8. (a) Determine the polar moment of inertia of the shaded area shown in Figure 8(a) with respect to (i) point O, (ii) the centroid of the area. **(17)**

   (b) Determine by direct integration the mass moment of inertia with respect to the y axis of the paraboloid shown in Figure 8 (b), assuming that it has a uniform density and a mass m. **(18)**

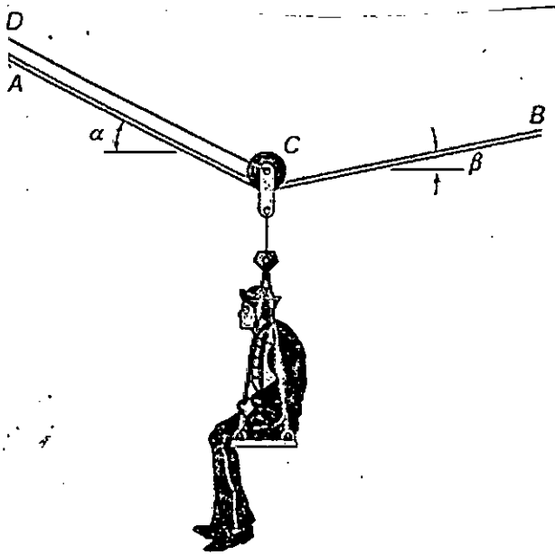


Fig. 1(a)

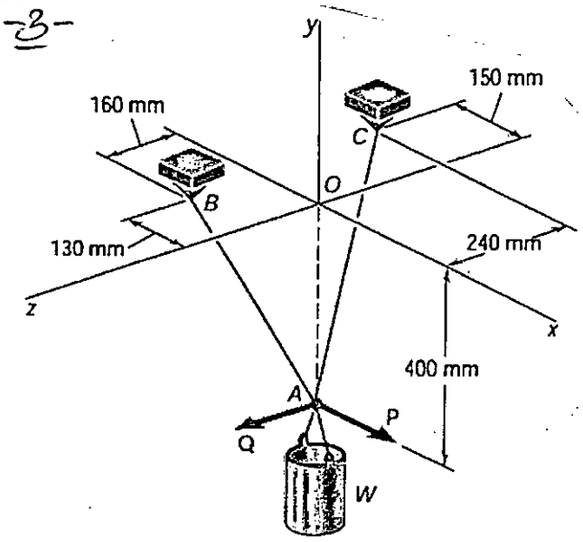


Fig. 1(b)

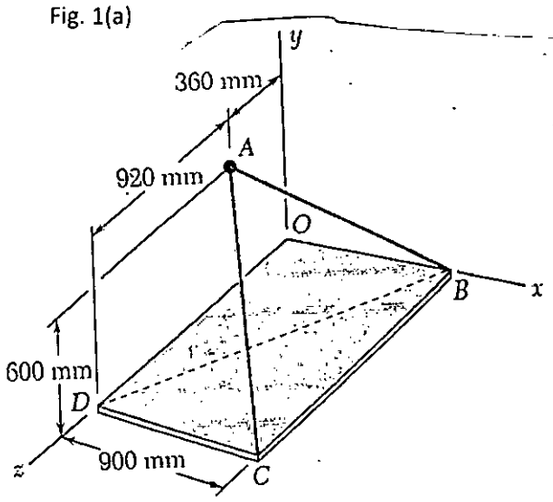


Fig. 2(a)

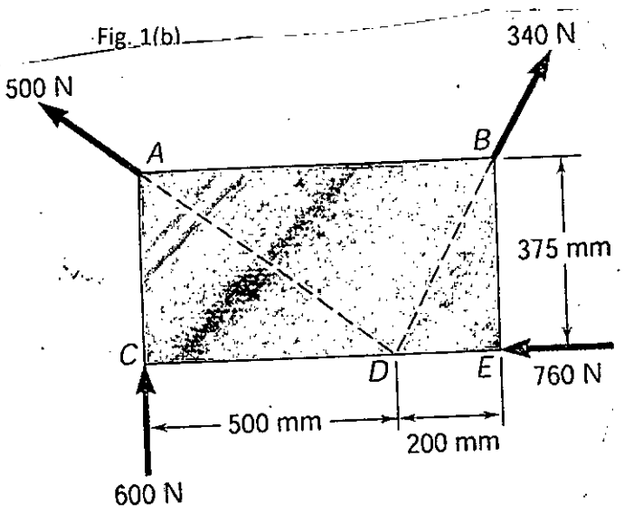


Fig. 2(b)

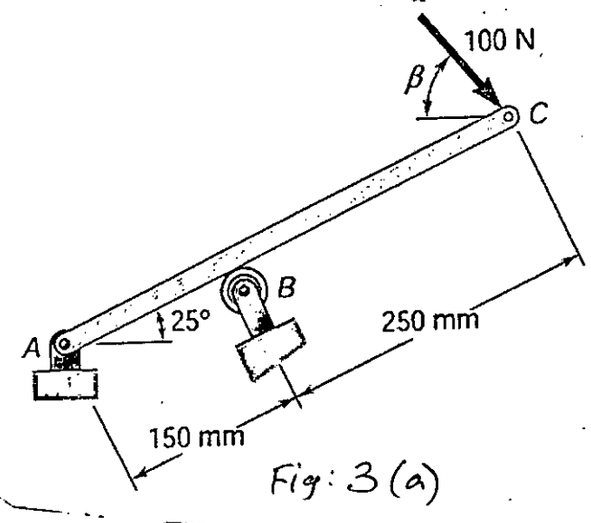


Fig: 3 (a)

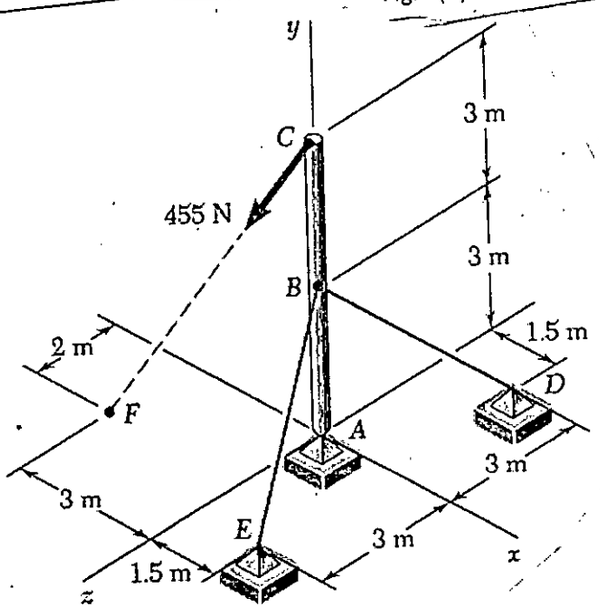


Fig 3 (b)

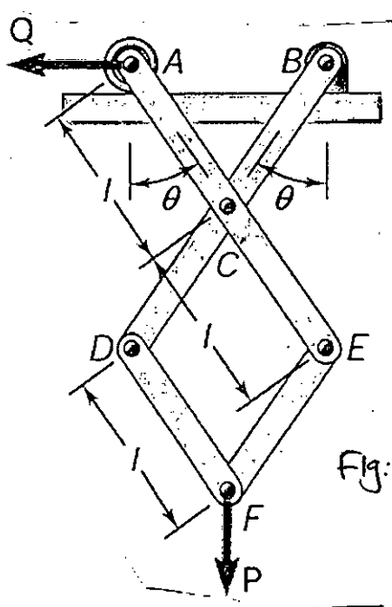


Fig: 4(a)

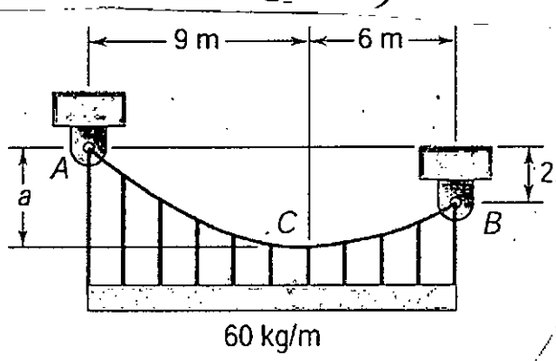


Fig. 4(b)

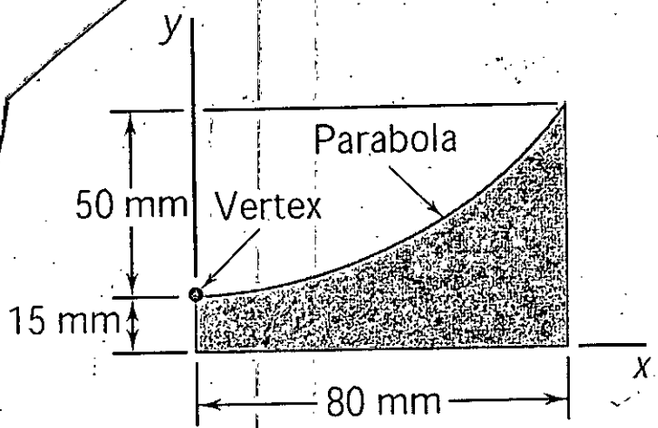
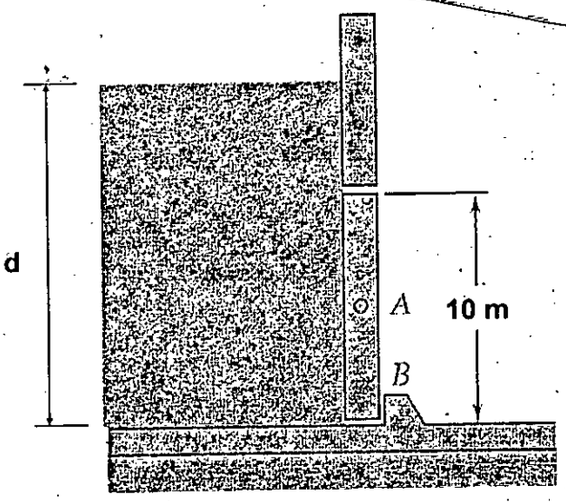


Figure for Q. No. 5 (a)



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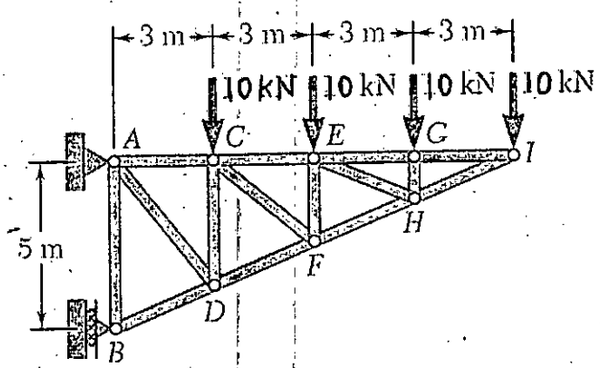

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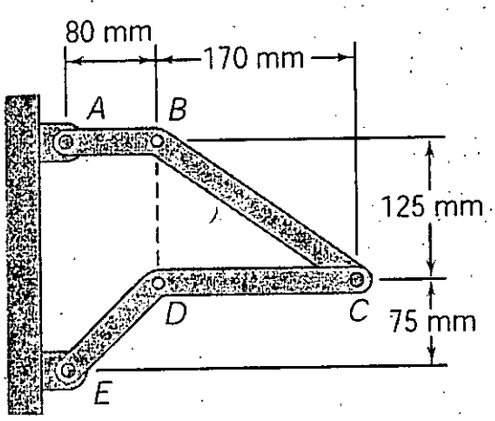

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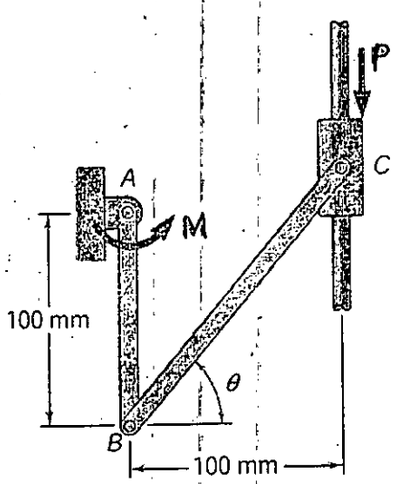


Figure for Q. No. 7 (a)

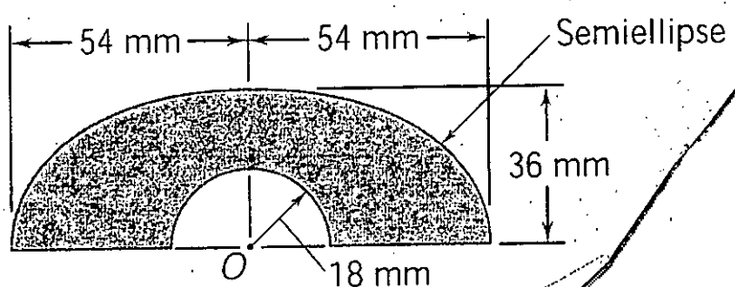


Figure for Q. No. 8 (a)

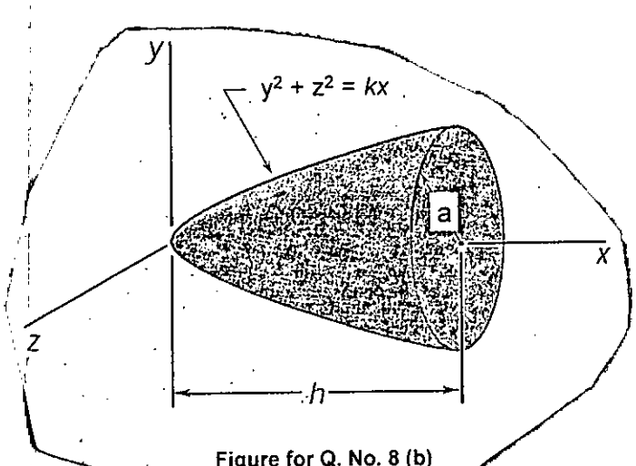


Figure for Q. No. 8 (b)

L-2/T-1/ME **Date : 30/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **ME 203** (Engineering Thermodynamics)

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**.

Symbols indicate their usual meanings. Assume reasonable value for any missing data.

1. (a) Explain what you know about energy, heat and work. Establish the relationship among these quantities for a closed system. **(15)**

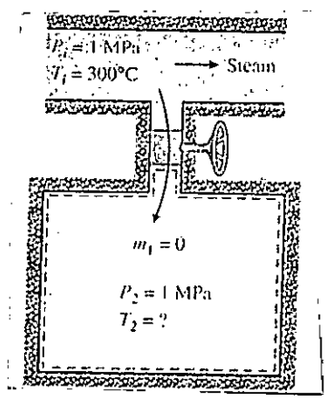
   (b) What is enthalpy of a pure substance? In a T-s diagram, schematically show the lines with constant pressure and enthalpy. **(6)**

   (c) An insulated piston-cylinder device contains 5 L of saturated liquid water at a constant pressure of 175 kPa. Water is stirred by a paddle wheel while a current of 8 A flows for 45 min through a resistor placed in the water. If one-half of the liquid is evaporated during this constant-pressure process and the paddle-wheel work amounts to 400 kJ, determine the voltage of the source. Also, show the process on a P-v diagram with respect to saturation lines. **(14)**

2. (a) What do you mean by flow work? Illustrate. **(8)**

   (b) The electric heating systems used in many houses consist of a simple duct with resistance heaters. Air is heated as it flows over resistance wires. Consider a 15-kW electric heating system. Air enters the heating section at 100 kPa and 17°C with a volume flow rate of 150 m^3/min. If heat is lost from the air in the duct to the surroundings at a rate of 200 W, determine the exit temperature of air. **(12)**

   (c) A rigid, insulated tank that is initially evacuated is connected through a valve to a supply line that carries steam at 1 MPa and 300°C. Now the valve is opened, and steam is allowed to flow slowly into the tank until the pressure reaches 1 MPa, at which point the valve is closed. Determine the final temperature of steam in the tank and the amount of steam entered in the tank. Consider the volume of the tank is 2 m^3. **(15)**



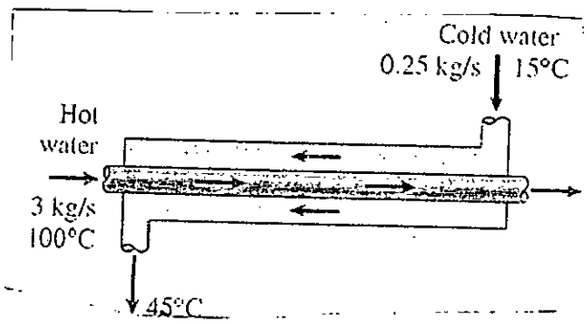
Contd P/2

ME 203

3. (a) After having sound knowledge on the first law of thermodynamics, why is the study of second law necessary? **(8)**

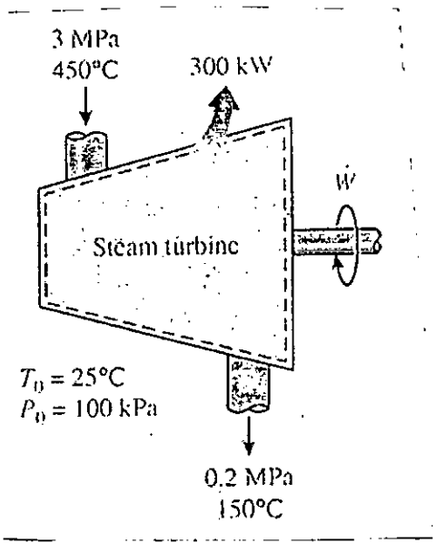
(b) Give a brief summary of your understanding on Entropy. **(7)**

(c) Cold water (c_p = 4.18 kJ/kg·°C) leading to a shower enters a well-insulated, thin-walled, doubled-pipe, counter-flow heat exchanger at 15°C at a rate of 0.25 kg/s and is heated to 45°C by hot water (c_p = 4.19 kJ/kg·°C) that enters at 100°C at a rate of 3 kg/s. Determine (i) the rate of heat transfer and (ii) the rate of entropy generation in the heat exchanger. Take T_0 = 25°C. **(20)**



4. (a) Write a short note on exergy. **(5)**

(b) Steam enters a turbine steadily at 4 MPa and 450°C at a rate of 8 kg/s and exits at 0.2 MPa and 150°C as shown in the figure. The steam is losing heat to the surrounding air at 100 kPa and 25°C at a rate of 300 kW, and the kinetic and potential energy changes are negligible. Determine (i) the actual power output, (ii) the maximum possible power output, (iii) the second-law efficiency, and (iv) the exergy destroyed. **(20)**



(c) The steam exiting the turbine as mentioned in the question 4(b) condenses to saturated liquid in a condenser by losing heat to the circulating cooling water. The entropy decreases during this condensation process. Is this a violation of the increase in entropy principle? Justify your answer by using suitable diagrams and entropy balance. **(10)**

Contd P/3

ME 203

SECTION - B

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

Symbols indicate their usual meanings. Assume reasonable value for any missing data.
Thermodynamics property table & charts will be supplied.

5. Consider a cogeneration power plant modified with regeneration. Steam enters the turbine at 6 MPA and 450°C and expands to a pressure of 0.4 MPa. At this pressure, 60 percent of the steam is extracted from the turbine, and the remainder expands to 10 kPa. Part of the extracted steam is used to heat the feed water in an open feed water heater. The rest of the extracted steam is used for process heating and leaves the process heater as a saturated liquid at 0.4 MPa. It is subsequently mixed with the feed water leaving the feed water heater as a saturated liquid at 0.4 MPa, and the mixture is pumped to the boiler pressure. Assuing the turbines and the pumps to be isentropic, show the cycle on a T-s diagram with respect to saturation lines, and determine the mass flow rate of steam through the boiler for a net power output of 15 MW. **(35)**

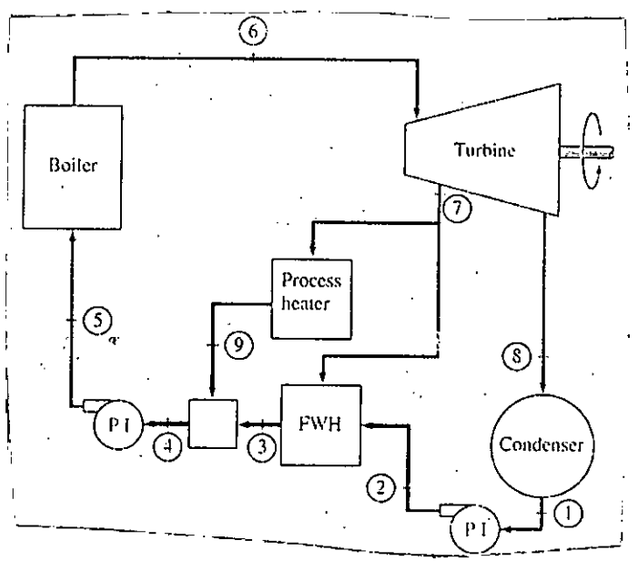


Fig. for Q. No. 5

6. (a) What is cascade refrigeration? What are the advantages and disadvantages of cascade refrigeration? How does the COP of a cascade refrigeration system compared to the COP of a simple vapor-compression cycle operating between the same pressure limits? **(10)**

(b) Refrigerant-134a enters the compressor of a refrigerator as superheated vapor at 0.14 MPa and −10°C at a rate of 0.05 kg/s and leaves at 0.8 MPa and 50°C. The refrigerant is cooled in the condenser to 26°C and 0.72 MPa and is throttled to 0.15 MPa. Disregarding any heat transfer and pressure drops in the connecting lines between the components, determine (i) the rate of heat removal from the refrigerated space and the power input to the compressor, (ii) the isentropic efficiency of the compressor, and (iii) the coefficient of performance of the refrigerator. **(25)**

Contd P/4

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7. (a) Consider an ideal air-standard Brayton cycle in which the air enters into the compressor at 100 kPa, 20°C, and the pressure ratio across the compressor is 12:1. The maximum temperature in the cycle is 1100°C, and the air flow rate is 10 kg/s. Assume constant specific heat for the air. Determine the compressor work, the turbine work, and the thermal efficiency of the cycle. **(17)**

(b) The compression ratio in an air-standard Otto cycle is 8. At the beginning of the compression stroke the pressure is 0.1 MPa and the temperature is 15°C. The heat transfer to the air per cycle is 1800 kJ/kg air. Determine: **(18)**

(i) The pressure and temperature at the end of each process of the cycle

(ii) The thermal efficiency

(iii) The mean effective pressure.

8. (a) An 8 m^3-tank contains saturated air at 30°C, 105 kPa. Determine (i) the mass of dry air, (ii) the specific humidity, and (iii) the enthalpy of the air per unit mass of the dry air. **(9)**

(b) Why is cooled air sometimes reheated in summer before it is discharge to a room? **(4)**

(c) A wet cooling tower is to cool 60 kg/s of water from 40 to 26°C. Atmospheric air enters the tower at 1 atm with dry- and wet-bulb temperatures of 22 and 16°C, respectively, and leaves at 34°C with a relative humidity of 90 percent. Using the psychrometric chart, determine (i) the volume flow rate of air into the cooling tower and (ii) the mass flow rate of the required makeup water. **(22)**

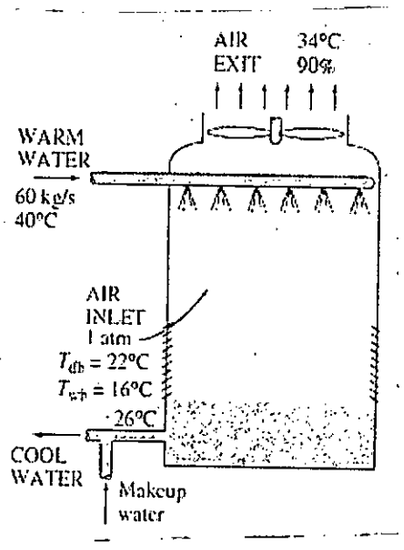


Fig. for Q. No. 8(c)

ME 203

Formula for ME203

Energy

$$E_{in} - E_{out} = \Delta E_{system}$$
$$\dot{E}_{in} - \dot{E}_{out} = dE_{system}/dt$$

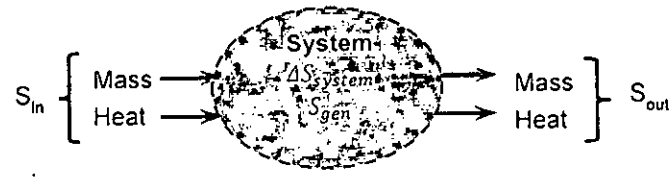
For closed system: $Q - W = \Delta U + \Delta KE + \Delta PE$

For control volume at steady flow condition:

$$\dot{Q} - \dot{W} = \dot{m}(h_2 - h_1) + \dot{m}\left(\frac{V_2^2 - V_1^2}{2}\right) + \dot{m}g\,(z_2 - z_1)$$

NB: Heat supplied to the system and work done by the system are considered positive

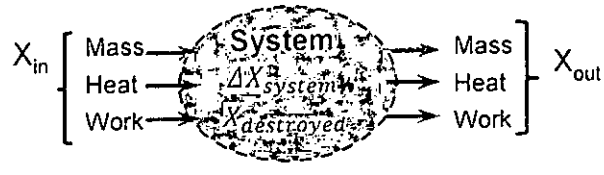
Entropy



$$S_{in} - S_{out} + S_{gen} = \Delta S_{system}$$
$$\dot{S}_{in} - \dot{S}_{out} + \dot{S}_{gen} = dS_{system}/dt$$

$$S_{heat} = \int \frac{\delta Q}{T}$$
$$S_{heat} = \frac{Q}{T}$$
$$S_{mass} = ms$$
$$\dot{S}_{mass} = \dot{m}s$$

Exergy



$$X_{in} - X_{out} - X_{destroyed} = \Delta X_{system}$$
$$\dot{X}_{in} - \dot{X}_{out} - \dot{X}_{destroyed} = dX_{system}/dt$$

$$\phi = (u - u_0) + P_0(v - v_0) - T_0(s - s_0) + \frac{V^2}{2} + gz$$
$$\psi = (h - h_0) - T_0(s - s_0) + \frac{V^2}{2} + gz$$

$$X_{heat} = \int \left(1 - \frac{T_0}{T}\right)\delta Q$$
$$X_{heat} = \left(1 - \frac{T_0}{T}\right)Q$$
$$X_{work} = W - W_{surr}$$

W_{surr}=0 for no boundary work

$$X_{mass,system} = m\phi$$
$$X_{mass,CV} = m\psi$$
$$\dot{X}_{dest} = T_0\dot{S}_{gen}$$

Efficiency

$$\eta_{th} = \frac{W_{net}}{Q_{in}} = \frac{w_{net}}{q_{in}} = 1 - \frac{q_{out}}{q_{in}}; \qquad \eta_{th,Carnot} = 1 - \frac{T_L}{T_H}$$

$$\eta_{II} = \frac{\eta_{th}}{\eta_{th,rev}} = \frac{w_u}{w_{rev}} = 1 - \frac{X_{dest}}{X_{Expended}}$$

Thermodynamic relations

$$Tds = du + Pdv \qquad Tds = dh - vdp$$

$$c_v = \frac{\partial u}{\partial T}; \qquad c_p = \frac{\partial h}{\partial T}; \qquad ds = \frac{\delta q}{T}$$

Psychrometric relations

$$\omega = \frac{0.622\,\emptyset\,P_g}{P - \emptyset\,P_g}; \qquad \emptyset = \frac{\omega\,P}{(0.622 + \omega)\,P_g}$$

$$h = h_a + \omega\,h_v \cong c_pT + \omega\,h_g$$

Symbols have their usual meanings