L-3/T-2/IPE **Date : 09/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **IPE 313** (Cost and Management Accounting)

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) Explain the term "fixed costs and relevant range". **(6)**

(b) Company X manufactures a wide range of products at several plant locations. The plant in Dhaka, which manufactures home appliances, has been experiencing difficulties with fluctuating monthly overhead costs. The fluctuations have made it difficult to estimate the level of overhead costs that will be incurred for any one month. Management wants to be able to estimate overhead costs accurately in order to better plan its operational and financial needs. The company have identified that overhead costs in the plant in Dhaka tends to vary with direct labor hours. They want to analyze the behavior of overhead costs with respect to machine hours. Data on machine hours and associated overhead costs for the last year are given below: **(24)**

Month	Machine Hours	Overhead Costs
January	20,050	$86,000
February	27,000	99,900
March	23,000	90,500
April	23,700	94,000
May	20,900	84,500
June	19,600	77,500
July	14,300	73,500
August	11,000	68,500
September	14,000	69,900
October	17,800	77,000
November	16,100	72,500
December	19,600	79,000

(i) Using the least-square method, determine the cost formula for overhead costs in the plant in Dhaka.

(ii) For any one month, machine hours in the plant in Dhaka are estimated to be 29,600 hours. What will be the expected overhead costs?

(c) Define various levels of activities with examples. **(5)**

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2. (a) Due to fluctuation in sales, Y is experiencing some problems. Company's income statement for the most recent month is given below: **(30)**

Sales (30,200 units * $42).....	$1,268,400
Less variable expense.....	815,400
Contribution margin.....	453,000
Less fixed expenses.....	380,000
Net Income.....	73,000

(i) Compute the company's CM ratio and its break-even point in both units and dollars.

(ii) The president is certain that a $26,000 increase in the monthly advertising budget, combined with an intensified effort by the sales staff will result in an $90,000 increase in monthly sales. If the President is right, what will be the effect on the company's net income or loss?

(iii) Refer to the original data, the sales manager is convinced that a 8% reduction in the selling price, combined with an increase of $50,000 in the monthly advertising budget, will cause unit sales to double. What will be the new income statement look like if these changes are adopted?

(iv) Refer to the original data, the marketing department thinks that a fancy new package would increase sales. The new package would increase packaging costs by $1.2 per unit. Assuming no other changes in cost behavior, how many units would have to be sold each month to earn a net income of $95,000?

(v) Refer to the original data, by automating certain operations, the company could reduce variable costs by $3 per unit. However, fixed costs would increase by $72,000 each month. Compute the new CM ratio and the new break-even point in both units and dollars. Assume that the company expects to sell 38,000 units next month. Prepare two income statements, one assuming that operations are not automated and one assuming that operations are automated. Would you recommend that the company automate its operations and why?

(vi) Refer to the original data, a large distributor has offered to make a bulk purchase of extra 5,000 units each month on a special price basis. Variable selling expenses of $1 per unit could be avoided on this sale. What price per unit should the company quote to the distributor if the company wants to make an overall net income of $98,000 each month for the company as a whole?

(b) Define operating leverage and explain its significance. **(5)**

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3. (a) The company Z manufactures a small part that is widely used in various electronic products such as home computers. Operating results for the last three years are as follows (absorption costing basis): **(20)**

	2011	2012	2013
Sales	$800,000	$640,000	$980,000
Cost of goods sold:			
Beginning inventory	0	0	200,000
Add costs of good manufactured	580,000	600,000	560,000
Goods available for sale	580,000	600,000	760,000
Less ending inventory	0	200,000	140,000
Cost of goods sold	580,000	400,000	620,000
Gross margin	220,000	240,000	180,000
Selling and administrative expenses	190,000	180,000	190,000
Net income (or loss)	$30,000	$60,000	$(10,000)

In the later part of 2012, a competitor went out of business and in the process dumped a large number of units on the market. As a result, company Z sales dropped by 20% during 2012 even though production increased during that year. Management has expected sales for remain constant at 50,000 units; the increased production was designed to provide the company with a buffer of protection against unexpected spurts in demand. By the start of 2013, management could see that inventory was excessive and that spurts in demand were unlikely. To work off the excessive inventories, the company cut back production during 2013, as shown below:

	2011	2012	2013
Production in units	50,000	60,000	40,000
Sales in units	50,000	40,000	50,000

Additional information about the company follows:

- The company's plant is highly automated. Variable manufacturing costs totaled only $2 per unit, and fixed manufacturing costs totaled $480,000 per year.
- Fixed manufacturing costs are applied to units of product on the basis of each year's production.
- Variable selling and administrative expenses are $1 per unit sold in each year. Fixed selling and administrative expenses totaled $140,000 each year.
- The company uses a FIFO inventory flow.

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The management cannot understand why profits doubled during 2012 when sales dropped by 20%, and why a loss incurred during 2013 when sales recovered to previous levels.

(i) Prepare a new income statement for each year using the variable costing approach.

(ii) Refer to the absorption costing income statement above, compute the cost to produce one unit of product in each year under absorption costing mentioning both the variable portion and fixed portion in the unit cost. Reconcile the variable costing and absorption costing net income figures for each year.

(iii) Refer to the absorption costing income statements, explain why net income is higher in 2012 that it is in 2011, in light of the fact that fewer units are sold in 2012.

(b) E Mines Inc. is contemplating the purchase of equipment to exploit a mineral deposit that is located on land to which company has mineral rights. An engineering and cost analysis has been made and it is expected that the following values would be associated with opening and operating a mine in the area: **(15)**

Cost of new equipment and timbers	$480,000
Working capital required	$220,000
Annual cash receipts for year 1-4	$190,000
Annual cash receipts for year 5-8	$220,000
Annual maintenance costs for year 2-8	$22,000
Cost to construct new roads in fourth years	$80,000
Salvage value of equipment	$85,000

It is estimated that mineral deposit would be exhausted after eight years. At that point, the working capital required would be released for reinvestment elsewhere. The company's cost of capital is 12%. Determine the net present value of the proposed mining project. Should the project be undertaken and why?

4. (a) Mention some examples of capital budgeting decisions. What is the significance of time adjusted rate of return? **(2+3=5)**

(b) The company G prepares its master budget on a quarterly basis. The following data have been estimated to assist in preparation of the master budget for the first quarter of 2014: **(30)**

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- As of December 2013, the company's general ledger showed the following account balance:

	Debits	**Credits**
Cash	$48,000	
Accounts Receivables	$224,000	
Inventory	$60,000	
Plant and Equipment	$370,000	
Accounts Payable		$93,000
Capital Stock		$500,000
Retained Earnings		$109,000
	$702,000	**$702,000**

- Actual sales for December and budgeted sales for the next four months are as follows:

December	$280,000
January	$400,000
February	$600,000
March	$300,000
April	$200,000

- Sales are 20% for cash and 80% on credit. Payments are collected in the month following sales. Accounts receivables at December 31 are a result of December credit sales.
- The company's gross profit rate is 40% of sales.
- Monthly expenses are budgeted as follows: salaries and wages, $27,000 per month; advertising, $70,000 per month; freight-out, 5% of sales; depreciation, $14,000 per month; other expenses, 3% of sales.
- At the end of each month, inventory is to be on hand equal to 25% of the following month's sales needs, stated at cost.
- 50% of a month's inventory purchase is paid for in the month of purchase; the other 50% is paid for in the following month.
- During February, the company will purchase a new copy machine for $1,700 cash. During March, other equipment will be purchased for cash at a cost of $84,500.
- During January, the company will declare and pay $45,000 in cash dividend.

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- The company must maintain a minimum cash balance of $30,000. An open line of credit is available at a local bank for any borrowing that may be needed during the quarter. All borrowing is done at the beginning of a month, and all repayments are made at the end of a month. Borrowings and repayments of principals must be in multiples of $1,000. Interest is paid only at the time of payment of principal. The interest rate is 12% per year. (Figure interest on whole month, e.g., 1/12, 2/12.)

Using the data above, complete the following statements and schedules for the first quarter of 2014:

(i) Schedule of expected cash collections:

	January	February	March	Quarter
Cash Sales	$80,000			
Credit Sales	$224,000			
Total Cash Collections	$304,000			

(ii) Inventory purchase budget:

	January	February	March	Quarter
Budgeted cost of goods sold	$240,000	$360,000		
Add: Desired ending inventory	$90,000			
Total needs	$330,000			
Deduct: Beginning inventory	$60,000			
Required purchase	$270,000			

For January sales: $400,000 sales * 60% = $240,000; $360,000* 25% = $90,000

(iii) Schedule of cash disbursements for purchases:

	January	February	March	Quarter
December purchase	$93,000			
January purchase ($270,000)	$135,000	$135,000		
February purchase				
March purchase				
Total cash disbursements	$228,000			

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(iv) Schedule of cash disbursements for expenses:

	January	**February**	**March**	**Quarter**
Salaries and wages	$27,000			
Advertising	$70,000			
Freight-out	$20,000			
Other expenses	$12,000			
Total cash disbursements	$129,000			

(v) Cash budget:

	January	**February**	**March**	**Quarter**
Cash balance, beginning	$48,000			
Add cash collections	$304,000			
Total cash available	$352,000			
Less disbursements				
Purchase of inventory	$228,000			
Operating expenses	$129,000			
Purchase of equipment	-			
Cash dividends	$45,000			
Total disbursements	$402,000			
Excess (deficiency) of cash	(52,000)			
Financing*				

*Financing amount has to be determined for each month.

(vi) Prepare an income statement for the quarter ending March 31, 2014 (Ignore income taxes).

(vii) Prepare a balance sheet as of March 31, 2014.

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SECTION – B

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

5. (a) Mention three different types of cost classification. **(5)**

(b) Fixed cost can be both fixed and variable — also the variable cost can be both fixed and variable — discuss with example. **(8)**

(c) Selected account balances for the year ended December 31 are provided below for Superior company: **(22)**

Selling and Administrative salaries	$110,000
Insurance, factory	8,000
Utilities, factory	45,000
Purchases of R/M	290,000
Indirect labor	60,000
Direct labor	?
Advertising expense	80,000
Cleaning supplies, factory	7,000
Sales commissions	50,000
Rent, factory	120,000
Maintenance, factory	30,000

Inventory balances at the beginning and the end of the year were as follows:

	Beginning	End
R/M	$40,000	$10,000
WIP	?	35,000
F/G	50,000	?

Total manufacturing costs for the year were $683,000; the goods available for sale totaled $740,000; and the cost of goods sold totaled $660,000.

(i) Prepare a schedule of cost of goods manufactured and cost of goods sold.

(ii) Assume that the company expects to produce 50,000 units next year. What per unit and total cost would you expect to be incurred for direct material?

6. A law firm employs a job-order costing system to accumulate cost chargeable to each client, and it is organized into two departments — Research and Documents department and Litigation department. The firm uses predetermined overhead rates to charge the costs of the mentioned departments to its clients. At the beginning of the year, the firm's management made the following estimates for the year: **(35)**

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	Department	
	Research & Documents	Litigation
Research-hours	24,000	—
Direct attorney-hours	9,000	18,000
Legal forms & supplies	$16,000	$5,000
Direct attorney cost	450,000	900,000
Overhead cost	840,000	360,000

The predetermined overhead rate in the Research and Documents department is based on direct attorney cost.

The costs charged to each client are made up of three elements: legal forms and supplies used, direct attorney costs incurred, and an applied amount of overhead from each department in which work is performed on the case.

Case 418-3 was initiated on February 23 and completed on May 16. During this period, the following cost and time were recorded on the case:

	Department	
	Research & Documents	Litigation
Research-hours	26	—
Direct attorney-hours	7	114
Legal forms & supplies	$80	$40
Direct attorney cost	350	5,700

i) Compute the predetermined overhead rate used during the year in the Research and Documents department. Compute the rate used in the Litigation department as well.

(ii) What would be the total cost charged to case 418-3 for each department and in total.

(iii) At the end of the year, the firm's record revealed the following actual cost and operating data for all cases handled during the year:

	Department	
	Research & Documents	Litigation
Research-hours	26,000	—
Direct attorney-hours	8,000	15,000
Legal forms & supplies	$19,000	6,000
Direct attorney cost	400,000	750,000
Departmental overhead cost	870,000	315,000

Determine the amount of under-or over-applied overhead cost in each department for the year.

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7. You are employed by Spirit Company, a manufacturer of digital watches. The company's CFO is trying to verify the accuracy of the ending work-in-process and finished goods inventories prior to closing of the books for the year. You have been asked to assist in this verification. The year-end balances shown on books are as follows: **(35)**

	Units	Costs
WIP, December 31 (50% complete as to labor & overhead)	300,000	$660,960
FG, December 31	200,000	1,009,800

Materials are added to production at the beginning of the manufacturing process, and overhead is applied to each product at the rate of 60% of direct labor cost. There was no finished goods inventory at the beginning of the year. A review of company's inventory and cost records has disclosed the following data, all of which are accurate:

		Costs	
	Units	Material	Labor
WIP, January 1 (80% complete as to labor & overhead)	200,000	$200,000	$315,000
Units started into production	1,000,000		
Costs added during the year:			
Material		1,300,000	
Labor			1,995,000
Units completed during the year	900,000		

The company uses the weighted-average cost method.

(i) Determine the equivalent units and costs per equivalent unit for materials, labor, and overhead for the year.

(ii) Determine the amount of cost that should be assigned to the ending WIP and FG inventories.

(iii) Prepare the necessary correcting journal entry to adjust the WIP and FG inventories to the correct balances as of December 31.

(iv) Determine the cost of goods sold for the year assuming there is no under-or over-applied overhead.

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8. (a) Briefly describe general levels of activities in Activity-based costing system. **(8)**

(b) Mention the benefits and limitations of Activity-based costing. **(7)**

(c) Define committed and discretionary fixed costs. **(5)**

(d) Last year, actual manufacturing overhead cost and actual activity of company X were recorded in the various activity centers as follows: **(15)**

Activity center	Actual O/H cost	Actual activity
Labor related	$2,50,000	28,000 DLH
Purchase order	96,000	980 orders
Product testing	1,90,000	1,450 tests
Template etching	4,00,000	12,000 templates
General factory	9,50,000	65,000 machine-hrs
Total O/H costs	18,86,000	

The activities were traceable to the company's four products as follows:

Activity center	Actual activity	Transactions Relating to Products			
		A	B	C	D
Labor related	28,000 DHL	6,000	5,500	8,500	8,000
Purchase order	980 orders	260	320	250	150
Product testing	1450 tests	350	250	425	425
Template etching	12000 templates	2,400	3,200	3,400	3,000
General factory	65000 m/c hrs	13,000	15,000	18,000	19,000

The company produced 4,000 units of Product A, 3,000 units of Product B, 4,000 units of Product C and 3,000 units of Product D. Determine the amount of overhead cost chargeable to each unit of products.

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TABLE J-3

Present Value of \$1; $P = \frac{F_n}{(1 + r)^n}$

Periods	4%	5%	6%	8%	10%	12%	14%	16%	18%	20%	22%	24%	26%	28%	30%	40%
1	0.962	0.952	0.943	0.926	0.909	0.893	0.877	0.862	0.847	0.833	0.820	0.806	0.794	0.781	0.769	0.714
2	0.925	0.907	0.890	0.857	0.826	0.797	0.769	0.743	0.718	0.694	0.672	0.650	0.630	0.610	0.592	0.510
3	0.889	0.864	0.840	0.794	0.751	0.712	0.675	0.641	0.609	0.579	0.551	0.524	0.500	0.477	0.455	0.364
4	0.855	0.823	0.792	0.735	0.683	0.636	0.592	0.552	0.516	0.482	0.451	0.423	0.397	0.373	0.350	0.260
5	0.822	0.784	0.747	0.681	0.621	0.567	0.519	0.476	0.437	0.402	0.370	0.341	0.315	0.291	0.269	0.186
6	0.790	0.746	0.705	0.630	0.564	0.507	0.456	0.410	0.370	0.335	0.303	0.275	0.250	0.227	0.207	0.133
7	0.760	0.711	0.665	0.583	0.513	0.452	0.400	0.354	0.314	0.279	0.249	0.222	0.198	0.178	0.159	0.095
8	0.731	0.677	0.627	0.540	0.467	0.404	0.351	0.305	0.266	0.233	0.204	0.179	0.157	0.139	0.123	0.068
9	0.703	0.645	0.592	0.500	0.424	0.361	0.308	0.263	0.225	0.194	0.167	0.144	0.125	0.108	0.094	0.048
10	0.676	0.614	0.558	0.463	0.386	0.322	0.270	0.227	0.191	0.162	0.137	0.116	0.099	0.085	0.073	0.035
11	0.650	0.585	0.527	0.429	0.350	0.287	0.237	0.195	0.162	0.135	0.112	0.094	0.079	0.066	0.056	0.025
12	0.625	0.557	0.497	0.397	0.319	0.257	0.208	0.168	0.137	0.112	0.092	0.076	0.062	0.052	0.043	0.018
13	0.601	0.530	0.469	0.368	0.290	0.229	0.182	0.145	0.116	0.093	0.075	0.061	0.050	0.040	0.033	0.013
14	0.577	0.505	0.442	0.340	0.263	0.205	0.160	0.125	0.099	0.078	0.062	0.049	0.039	0.032	0.025	0.009
15	0.555	0.481	0.417	0.315	0.239	0.183	0.140	0.108	0.084	0.065	0.051	0.040	0.031	0.025	0.020	0.006
16	0.534	0.458	0.394	0.292	0.218	0.163	0.123	0.093	0.071	0.054	0.042	0.032	0.025	0.019	0.015	0.005
17	0.513	0.436	0.371	0.270	0.198	0.146	0.108	0.080	0.060	0.045	0.034	0.026	0.020	0.015	0.012	0.003
18	0.494	0.416	0.350	0.250	0.180	0.130	0.095	0.069	0.051	0.038	0.028	0.021	0.016	0.012	0.009	0.002
19	0.475	0.396	0.331	0.232	0.164	0.116	0.083	0.060	0.043	0.031	0.023	0.017	0.012	0.009	0.007	0.002
20	0.456	0.377	0.312	0.215	0.149	0.104	0.073	0.051	0.037	0.026	0.019	0.014	0.010	0.007	0.005	0.001
21	0.439	0.359	0.294	0.199	0.135	0.093	0.064	0.044	0.031	0.022	0.015	0.011	0.008	0.006	0.004	0.001
22	0.422	0.342	0.278	0.184	0.123	0.083	0.056	0.038	0.026	0.018	0.013	0.009	0.006	0.004	0.003	0.001
23	0.406	0.326	0.262	0.170	0.112	0.074	0.049	0.033	0.022	0.015	0.010	0.007	0.005	0.003	0.002	
24	0.390	0.310	0.247	0.158	0.102	0.066	0.043	0.028	0.019	0.013	0.008	0.006	0.004	0.003	0.002	
25	0.375	0.295	0.233	0.146	0.092	0.059	0.038	0.024	0.016	0.010	0.007	0.005	0.003	0.002	0.001	
26	0.361	0.281	0.220	0.135	0.084	0.053	0.033	0.021	0.014	0.009	0.006	0.004	0.002	0.002	0.001	
27	0.347	0.268	0.207	0.125	0.076	0.047	0.029	0.018	0.011	0.007	0.005	0.003	0.002	0.001	0.001	
28	0.333	0.255	0.196	0.116	0.069	0.042	0.026	0.016	0.010	0.006	0.004	0.002	0.002	0.001	0.001	
29	0.321	0.243	0.185	0.107	0.063	0.037	0.022	0.014	0.008	0.005	0.003	0.002	0.001	0.001	0.001	
30	0.308	0.231	0.174	0.099	0.057	0.033	0.020	0.012	0.007	0.004	0.003	0.002	0.001	0.001		
40	0.208	0.142	0.097	0.046	0.022	0.011	0.005	0.003	0.001	0.001						

TABLE J-4

Present Value of an Annuity of \$1 in Arrears; $P_n = \frac{1}{r}\left[1 - \frac{1}{(1 + r)^n}\right]$

Periods	4%	5%	6%	8%	10%	12%	14%	16%	18%	20%	22%	24%	26%	28%	30%	40%
1	0.962	0.952	0.943	0.926	0.909	0.893	0.877	0.862	0.847	0.833	0.820	0.806	0.794	0.781	0.769	0.714
2	1.886	1.859	1.833	1.783	1.736	1.690	1.647	1.605	1.566	1.528	1.492	1.457	1.424	1.392	1.361	1.224
3	2.775	2.723	2.673	2.577	2.487	2.402	2.322	2.246	2.174	2.106	2.042	1.981	1.923	1.868	1.816	1.589
4	3.630	3.546	3.465	3.312	3.170	3.037	2.914	2.798	2.690	2.589	2.494	2.404	2.320	2.241	2.166	1.879
5	4.452	4.330	4.212	3.993	3.791	3.605	3.433	3.274	3.127	2.991	2.864	2.745	2.635	2.532	2.436	2.035
6	5.242	5.076	4.917	4.623	4.355	4.111	3.889	3.685	3.498	3.326	3.167	3.020	2.885	2.759	2.643	2.168
7	6.002	5.786	5.582	5.206	4.868	4.564	4.288	4.039	3.812	3.605	3.416	3.242	3.083	2.937	2.802	2.263
8	6.733	6.463	6.210	5.747	5.335	4.968	4.639	4.344	4.078	3.837	3.619	3.421	3.241	3.076	2.925	2.331
9	7.435	7.108	6.802	6.247	5.759	5.328	4.946	4.607	4.303	4.031	3.786	3.566	3.366	3.184	3.019	2.379
10	8.111	7.722	7.360	6.710	6.145	5.650	5.216	4.833	4.494	4.192	3.923	3.682	3.465	3.269	3.092	2.414
11	8.760	8.306	7.887	7.139	6.495	5.988	5.453	5.029	4.656	4.327	4.035	3.776	3.544	3.335	3.147	2.438
12	9.385	8.863	8.384	7.536	6.814	6.194	5.660	5.197	4.793	4.439	4.127	3.851	3.606	3.387	3.190	2.456
13	9.986	9.394	8.853	7.904	7.103	6.424	5.842	5.342	4.910	4.533	4.203	3.912	3.656	3.427	3.223	2.468
14	10.563	9.899	9.295	8.244	7.367	6.628	6.002	5.468	5.008	4.611	4.265	3.962	3.695	3.459	3.249	2.477
15	11.118	10.380	9.712	8.559	7.606	6.811	6.142	5.575	5.092	4.675	4.315	4.001	3.726	3.483	3.268	2.484
16	11.652	10.838	10.106	8.851	7.824	6.974	6.265	5.669	5.162	4.730	4.357	4.033	3.751	3.503	3.283	2.489
17	12.166	11.274	10.477	9.122	8.022	7.120	6.373	5.749	5.222	4.775	4.391	4.059	3.771	3.518	3.295	2.492
18	12.659	11.690	10.828	9.372	8.201	7.250	6.467	5.818	5.273	4.812	4.419	4.080	3.786	3.529	3.304	2.494
19	13.134	12.085	11.158	9.604	8.365	7.366	6.550	5.877	5.316	4.844	4.442	4.097	3.799	3.539	3.311	2.496
20	13.590	12.462	11.470	9.818	8.514	7.469	6.623	5.929	5.353	4.870	4.460	4.110	3.808	3.546	3.316	2.497
21	14.029	12.821	11.764	10.017	8.649	7.562	6.687	5.973	5.384	4.891	4.476	4.121	3.816	3.551	3.320	2.498
22	14.451	13.163	12.042	10.201	8.772	7.645	6.743	6.011	5.410	4.909	4.488	4.130	3.822	3.556	3.323	2.498
23	14.857	13.489	12.303	10.371	8.883	7.718	6.792	6.044	5.432	4.925	4.499	4.137	3.827	3.559	3.325	2.499
24	15.247	13.799	12.550	10.529	8.985	7.784	6.835	6.073	5.451	4.937	4.507	4.143	3.831	3.562	3.327	2.499
25	15.622	14.094	12.783	10.675	9.077	7.843	6.873	6.097	5.467	4.948	4.514	4.147	3.834	3.564	3.329	2.499
26	15.983	14.375	13.003	10.810	9.161	7.896	6.906	6.118	5.480	4.956	4.520	4.151	3.837	3.566	3.330	2.500
27	16.330	14.643	13.211	10.935	9.237	7.943	6.935	6.936	5.492	4.964	4.525	4.154	3.839	3.567	3.331	2.500
28	16.663	14.898	13.406	11.051	9.307	7.984	6.961	6.152	5.502	4.970	4.528	4.157	3.840	3.568	3.331	2.500
29	16.984	15.141	13.591	11.158	9.370	8.022	6.983	6.166	5.510	4.975	4.531	4.159	3.841	3.569	3.332	2.500
30	17.292	15.373	13.765	11.258	9.427	8.055	7.003	6.177	5.517	4.979	4.534	4.160	3.842	3.569	3.332	2.500
40	19.793	17.159	15.046	11.925	9.779	8.244	7.105	6.234	5.548	4.997	4.544	4.166	3.846	3.571	3.333	2.500

L-3/T-2/IPE Date : 26/05/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : IPE 319 (Quality Management)

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) Eastern Pumps Ltd. produces water pumps, with a target output power of 38 horse power (hp). This quality factor requires Nominal-the-best output. As per goal-post view of specifications, with 3-σ control, limits of (38 ± 9) hp is used. The company produces nearly 1000 units of pumps everyday. If Taguchi Loss Function for multiple pieces of products is used, rework will be required with certain costs associated. It is estimated that the average cost/loss is $ 250 at a deviation of 9 hp. At the end of the production line, quality inspection shows that the average output power of the pumps is 40 hp. What is the loss incurred as per Taguchi Loss Function? (20)

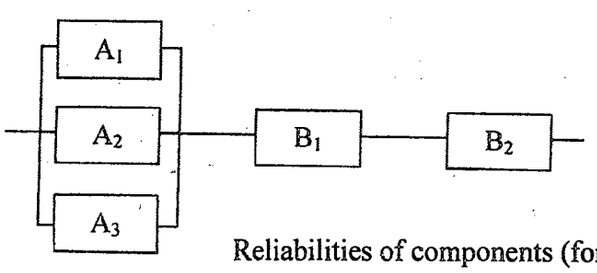
   (b) Explain "Bigger-the-better", along with its Taguchi Loss Functions. (15)

2. (a) An agreement between a producer and a buyer states the following data (with usual meanings): $\alpha = 0.05$, $\beta = 0.12$, $P_1 = 0.02$, $P_2 = 0.10$

   Compute and write the Acceptance Limit Line and Rejection Limit Line for Sequential Sampling Plan. (No need to plot). (20)

   (b) Explain Bath-tub curve with respect to reliability, along with distributions it follows at different times. (15)

3. (a) Consider a system with the following series-parallel components, along with their reliabilities for 100 hours of operation. (20)



Reliabilities of components (for 100 hours of operation) are:

$A_1 = A_2 = A_3 = 0.80$; $B_1 = 0.97$; $B_2 = 0.98$

What are the overall System failure rate (per 10,000 hours) and MTBF?

(b) Describe certification schemes of six-sigma management in quality control. (15)

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4. (a) What is a special type of control chart? Explain. **(20)**

   (b) Why is $\overline{X} - S$ chart more practical and useful than $\overline{X} - R$ chart? **(10)**

   (c) What Dodge and Roming are popular for? **(5)**

SECTION – B

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

5. (a) What are the consequences of Poor Quality? Explain. **(12)**

   (b) Describe different aspects of Quality. **(12)**

   (c) Classify cost of quality with suitable examples. **(11)**

6. (a) What do you mean by "Total Quality Management"? What are the main distinguishing characteristics of TQM? Describe. **(12)**

   (b) Describe Pareto analysis. **(12)**

   (c) How will you define BPR? How does BPR defer from TQM? Why a large number of BPR projects fail? **(11)**

7. (a) Summarize the history of Malcolm Baldrige National Quality Award. How many awards are given each year? What are the criteria for assessment for this award? **(12)**

   (b) Write short note on ISO9000 Quality Management System. Summarize its background, documentation system, audit and certification system, major clauses, problems and Prospects. **(15)**

   (c) What types of errors may happen in Control Charts? Explain. **(08)**

8. (a) "First Choice Workshop Ltd." produces some shafts to be inserted to a machine, where outside diameter is an important quality characteristic. The inspector collects sample of size 5 each on a day. Mean values, ranges and standard deviations are calculated in millimeter, as shown in the following table. Set the control limits and develop "$\overline{X} - S$ Charts". Mention the remarkable signs on your developed charts. **(18)**

Sample i	$\bar{X}$	R	S	Sample i	$\bar{X}$	R	S
1	9.986	0.23	0.098	12	10.014	0.19	0.075
2	10.05	0.14	0.068	13	10.064	0.14	0.065
3	10.008	0.19	0.073	14	10.008	0.14	0.055
4	10.034	0.22	0.098	15	10.012	0.1	0.041
5	9.998	0.08	0.033	16	10.022	0.12	0.058
6	9.986	0.18	0.075	17	9.978	0.21	0.084
7	10.018	0.24	0.094	18	10.022	0.22	0.089
8	10.00	0.19	0.086	19	10.03	0.22	0.098
9	9.996	0.18	0.065	20	10.006	0.21	0.090
10	10.05	0.16	0.078	21	9.988	0.15	0.065
11	10.02	0.15	0.063	22	10.042	0.15	0.066

Contd P/3

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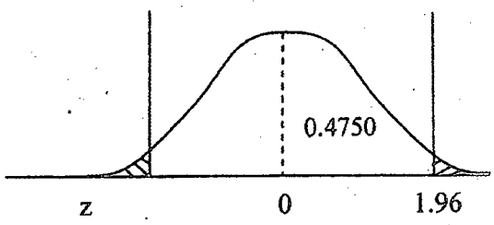
Contd ... Q. No. 8

(b) For the shafts produced in the "First Choice Workshop Ltd", as data given in question 8.(a) Upper Specification Limit is given as 10.25 mm and Lower Specification Limit is given as 9.75 mm. Calculate Process Potential Index, Process performance Index and Process Centering Index. Hence justify whether the process is capable or not. (12)

(c) What is Operating Characteristics Curve? (5)

Table. Standard Normal Distribution Values (Areas under the normal curve).



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0/09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Contd P/4

Table B. Factors used in 3σ Quality Control Charts.

Sample size n	$\bar{X}$ charts			S charts					R charts					
	Factors for control limits			Factors for central line	Factors for control limits				Factors for central line	Factors for control limits				
	A	A_2	A_3	c_4	B_3	B_4	B_5	B_6	d_2	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	0	3.267	0	2.606	1.128	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	0	2.568	0	2.276	1.693	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	0	2.266	0	2.088	2.059	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	0	2.089	0	1.964	2.326	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	0.030	1.970	0.029	1.874	2.534	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	0.118	1.882	0.113	1.806	2.704	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	0.185	1.815	0.179	1.751	2.847	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	0.239	1.761	0.232	1.707	2.970	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	0.284	1.716	0.276	1.669	3.078	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	0.321	1.679	0.313	1.637	3.173	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	0.354	1.646	0.346	1.610	3.258	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	0.382	1.618	0.374	1.585	3.336	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	0.406	1.594	0.399	1.563	3.407	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	0.428	1.572	0.421	1.544	3.472	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	0.448	1.552	0.440	1.526	3.532	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	0.466	1.534	0.458	1.511	3.588	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	0.482	1.518	0.475	1.496	3.640	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	0.497	1.503	0.490	1.483	3.689	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	0.510	1.490	0.504	1.470	3.735	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	0.523	1.477	0.516	1.459	3.778	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	0.534	1.466	0.528	1.448	3.819	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	0.545	1.455	0.539	1.438	3.858	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	0.555	1.445	0.549	1.429	3.895	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	0.565	1.435	0.559	1.420	3.931	0.708	1.806	6.056	0.459	1.541

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L-3/T-2/IPE **Date : 02/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **IPE 317** (Product Design-II)

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.

The text book titled "Fundamentals of Mechanical component Design" by K. S. Edwards and R. B Makee is supplied.

1. (a) The sketch in Fig. 1(a) shows a gear driven shaft supported on two bearings. The gear has a pitch diameter of 160 mm. The shaft to be made of 1040 steel cold drown 20 percent, is to transmit 900 hp at 800 rpm with 95 percent reliability. Determine the size of the shaft according to ASME standard, with FS = 2. **(23)**

   (b) For the section shown in Fig. 1(b), calculate the torsional constant. **(12)**

2 The diameter of the flange as shown in Fig. 2. is 4 in; the bolts are on a 3-in diameter, and the shaft size is 1.5 in. The flanges are 0.5 in thick. There are two $\frac{1}{2}$-13 UNC ×1.5 grade 7 bolts, preloaded dry with a manual torque wrench to the yield. What minimum force P can be expected to cause separation of the joint? **(35)**

3. Fig. 3 shows the schematic of a vertically mounted motor armature. The sum of the belt tensions are: **(35)**

   150 lb at 945 rpm for 50% of time

   122 lb at 1230 rpm for 20% of time

   93 lb at 1790 rpm for 30% of time

   There are light shock conditions. Choose the suitable bearings for a life of 10000 h with reliability of 98 percent.

4. A 10-pitch 20° full-depth involute gearset with a face width of 1-25 inches is being proposed to provide a 2 : 1 speed reduction for a conveyor drive unit. The 18 tooth pinion is to be driven by a 15 hp. 1725 rpm electric motor operating steadily at full rated power. A very long life is desired for this gear set and a reliability of 99 percent is required. Now do the following: **(35)**

   (i) Using the simplified approach estimate the nominal bending stress at the tension side root fillet of driving pinion.

   (ii) Calculate actual bending stress at the tension side root fillet of the driving pinion. Assume e/h = 1.35.

Contd P/2

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(iii) Repeat (i) and (ii) for driven gear.

(iv) Based on the recommendation of an in-house materials specialist Grade-I AISI 4620 hot rolled steel is to be used for both pinion and gear.

The value of k_∞ has been estimated for this application to be 0.75. Estimate the existing safety factor at tension side root fillet of whichever of the gears is more critical based on tooth demanding fatigue.

(v) Using AGMA refined approach; calculate the tooth bending stress at the tension side root fillet of the driving pinion.

(vi) If the proposed material for both gears is AISI 4620 through hardened to BHN 207, estimate the existing factor of safety for the pinion.

Use the data sheet attached to your question wherever necessary. In case of any missing value use your assumption.

SECTION – B

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

5. (a) The Torque on a machined torsion bar varies from an unspecified maximum T_{max} to a minimum value $T_{min} = -2Tmax/3$. Also 250 in.lb of energy must be absorbed at the peak torque with a total angle of twist less than 5 degree. The diameter must be greater than 2 and less than 4 in. and length is greater than 25 in. Use FS = 2. Determine the minimum value of pick torque. **(25)**

(b) An M16 × 1.5 bolt is to be tightened to achieve a force of 57 kN. Find the nominal torque if the bolt is tightened dry. **(10)**

6. (a) Describe various causes of failure at different life phases of a product. How these failures can be prevented? **(12)**

(b) Briefly explain the 'safety hierarchy method' of design for safety. **(5)**

(c) A continuous and aligned fiber-reinforced composite is to be produced consisting of 45 vol% aramid fibers and 55 vol% of a polycarbonate matrix; mechanical characteristics of these two materials are as follows: **(18)**

	Modulus of Elasticity[GPa]
Aramid fiber	131
Polycarbonate	2.4

For this composite,

(i) Compute the longitudinal and transverse modulus of elasticity.

(ii) Assume that the composite has a cross-sectional area of 480 mm^2 and is subjected to a longitudinal load of 53,400 N. Compute the actual loads carried by both fiber and matrix phases.

(iii) What strain is experienced by the composite when the load in part (ii) is applied?

Contd P/3

IPE 317

7. (a) Explain the influence of fiber length and fiber orientation on the characteristics of fiber-reinforced composite. **(10)**

(b) A [90/0 /90] laminate consisting of 0.25 mm thick AS/3501 carbon fibre - epoxy laminate is subjected to a load of $N_x = N_y = 1000$ N/m. The ply moduli are $E_{11} = 138$ GPa. $E_{22} = 9$ GPa, $\nu_{12} = 0.3$, $\nu_{21} = 0.03$, $G_{12} = 6.9$ GPa. Find the stiffness matrix and mid-plane strains for his laminate. Use the following equations for your convenience. **(25)**

$$\overline{Q_{11}} = C_{11}m^4 + 2(C_{12} + 2C_{66})\, n^2m^2 + C_{22}n^4$$
$$Q_{22} = C_{11}n^4 + 2(C_{12} + 2C_{66})\, n^2m^2 + C_{22}m^4$$
$$Q_{12} = (C_{11} + C_{22} - 4C_{66})\, n^2m^2 + C_{12}(n^4 + m^4)$$
$$Q_{66} = (C_{11} + C_{22} - 2C_{12} - 2C_{66})\, n^2m^2 + C_{66}(n^4 + m^4)$$
$$Q_{16} = (C_{11} - C_{12} - 2C_{66})\, n\, m^3 + (C_{12} - C_{22} + 2C_{66})\, n^3\, m$$
$$Q_{26} = (C_{11} - C_{12} - 2C_{66})\, n^3\, m + (C_{12} - C_{22} + 2C_{66}) n\, m^3$$

8. (a) What is design for maintainability? How to enhance to maintainability of a product? **(17)**

(b) Write short notes on: **(12)**

(i) Design for Disassembly

(ii) Design for Waste Minimization

(iii) Design for Material Conservation

(c) What is reverse engineering? Name the steps of a reverse engineering and redesign product development process. **(6)**

Contd P/4

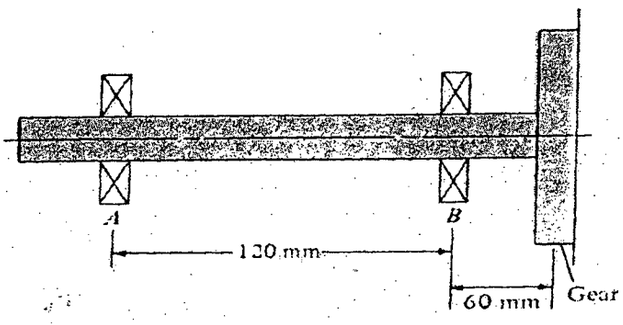

Fig: 1(a)

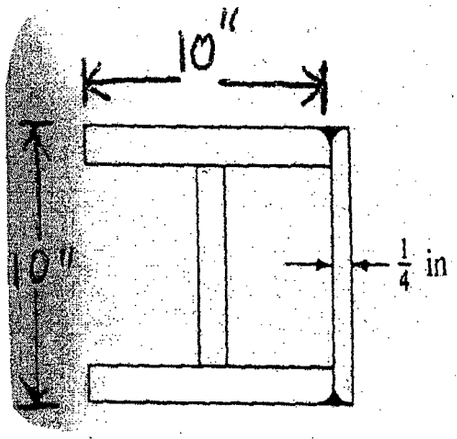

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Fig: 1(b)

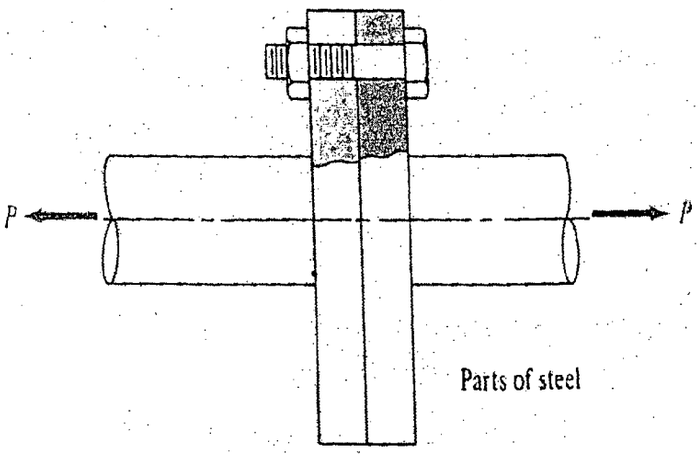

Fig: 2

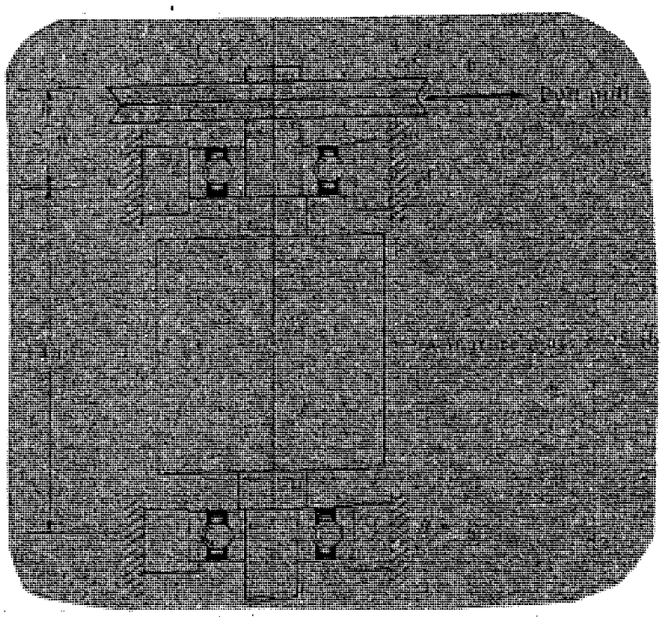

Fig: 3

TABLE 15.6 Application Factor, K_a

Prime Mover Characteristic	Driven Machine Characteristic: Uniform	Moderate Shock	Heavy Shock
Uniform (e.g., electric motor, turbine)	1.00	1.25	1.75 or higher
Light shock (e.g., multicylinder engine)	1.25	1.50	2.00 or higher
Medium shock (e.g., single-cylinder engine)	1.50	1.75	2.25 or higher

TABLE 15.7 Mounting Factor, K_m

Support Properties and Gear Quality	Face Width, in: 0 to 2	6	9	≥ 16
Accurate mountings, small bearing clearances, minimum deflections, precision gears	1.3	1.4	1.5	1.8
Less rigid mountings, more bearing clearance, less accurate gears, contact across full face	1.6	1.7	1.8	2.2
Combinations of mounting properties and gearing precision that produce less than full face contact	2.2 or higher			

Contd.... P/5

TABLE 15.8 AGMA Geometry Factor *J* for Bending of 20° Full-Depth Involute Teeth Under *Tip Loading* (used for lower precision gearing)

Gear Teeth	Pinion Teeth: 12		14		17		21		26		35		55		135	
	P[1]	G	P	G	P	G	P	G	P	G	P	G	P	G	P	G
12	U[2]	U														
14	U	U	U	U												
17	U	U	U	U	U	U										
21	U	U	U	U	U	U	0.24	0.24								
26	U	U	U	U	U	U	0.24	0.25	0.25	0.25						
35	U	U	U	U	U	U	0.24	0.26	0.25	0.26	0.26	0.26				
55	U	U	U	U	U	U	0.24	0.28	0.25	0.28	0.26	0.28	0.28	0.28		
135	U	U	U	U	U	U	0.24	0.29	0.25	0.29	0.26	0.29	0.28	0.29	0.29	0.29

[1] P = pinion; G = gear.
[2] U indicates a combination that produces undercutting.

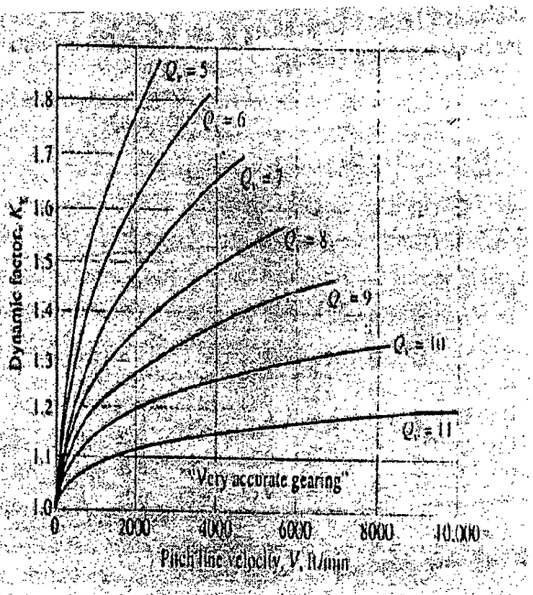

Figure 15.24
Dynamic factor K_v. The gearing quality values Q_v are a function of gearing accuracy (primarily based on transmission error). See Table 15.4 for guidance. (Adapted from ANSI/AGMA Standard 2001-C95, with the permission of the publisher, American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, VA 22314.)

TABLE 15.10 ANSI/AGMA Tooth Bending Fatigue Strength S_{tN} for Steel Gears[1]

Material	Heat Treatment	Metallurgical Quality[2] Grade 1: Min. Surf. Hardness	Grade 1: S_{tN}, ksi	Grade 2: Min. Surf. Hardness	Grade 2: S_{tN}, ksi	Grade 3: Min. Surf. Hardness	Grade 3: S_{tN}, ksi
Steel	Through hardened	See Figure 15.25					
	Flame or induction hardened, including root	—	35	28 R_C[3]	55	—	—
	Flame or induction hardened, except root	—	22	—	22	—	—
	Carburized and hardened (Min. core hard.)	55–64 R_C (21 R_C)	55	58–64 R_C (25 R_C)	65	58–64 R_C (30 R_C)	75
AISI 4140, AISI 4340 steel	Nitrided and through hardened	83.5 R_{15N}	see Figure 15.26	83.5 R_{15N}	see Figure 15.26	83.5 R_{15N}	—
Nitralloy 135 M, Nitralloy N, and 2.5% chrome (no aluminum)	Nitrided	87.5 R_{15N}	see Figure 15.27	87.5 R_{15N}	see Figure 15.27	87.5 R_{15N}	see Figure 15.27

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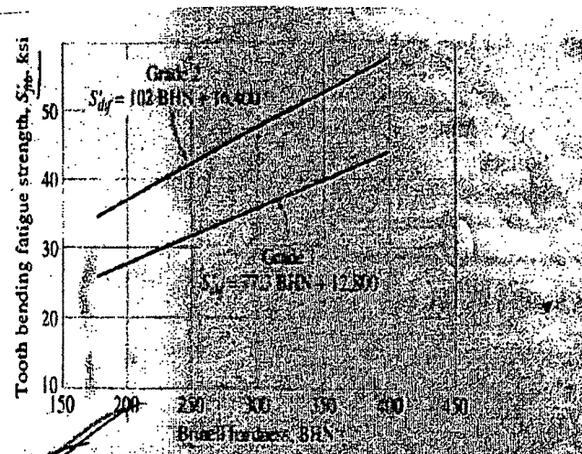

Figure 15.25
ANSI/AGMA tooth bending fatigue strength S_{at} for through-hardened gears. Curves are based on 99 percent reliability for a life of 10^7 cycles of one-way loading. See Table 15.11 for quality characteristics of specified grade. (Adapted from ANSI/AGMA Standard 2001-C95, with the permission of the publisher, American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, VA 22314.)

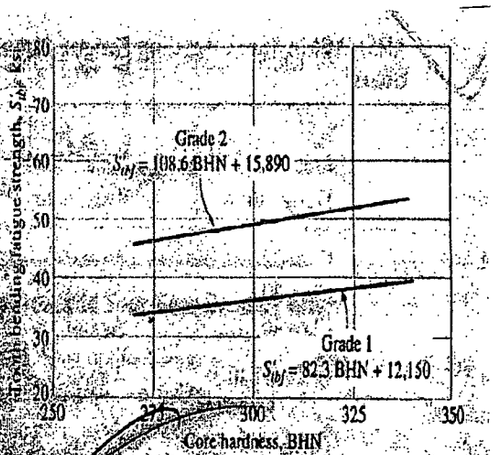

Figure 15.26
ANSI/AGMA tooth bending fatigue strength for nitrided through-hardened gears (AISI 4140 and 4340). Curves are based on 99 percent reliability for a life of 10^7 cycles of one-way loading. See Table 15.11 for quality characteristics of specified grade. (Adapted from ANSI/AGMA Standard 2001-C95, with the permission of the publisher, American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, VA 22314.)

TABLE 15.13 AGMA Reliability Adjustment Factor R_s for Gears[1]

Desired Reliability, percent	R_s
99.99	0.67
99.9	0.80
99	1.0
90	1.18
50	1.43

From ref. 10.

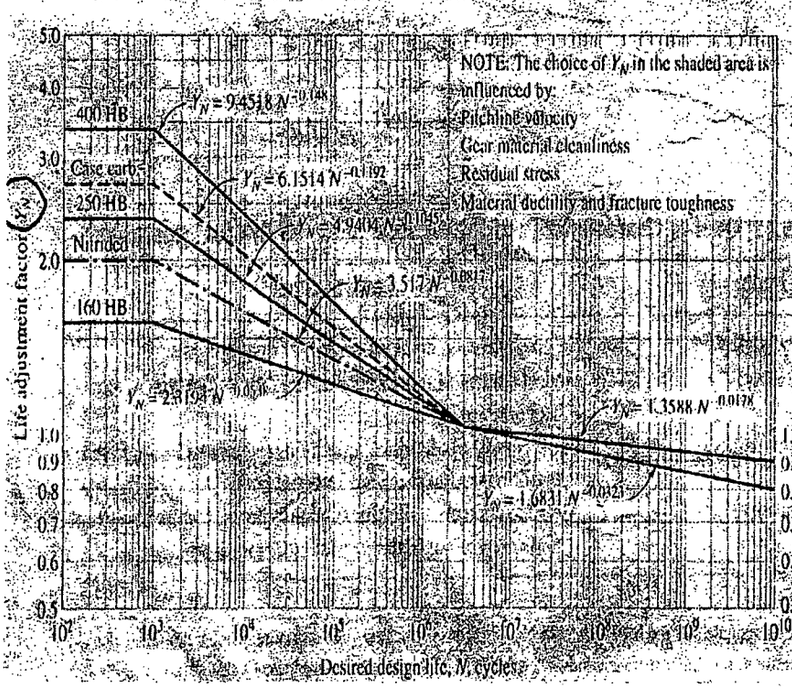

Figure 15.28
Life adjustment factor for adjusting the ANSI/AGMA bending fatigue strength to a life other than 10^7 cycles. Valid only for steel materials. (Adapted from ANSI/AGMA Standard 2001-C95, with the permission of the publisher, American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, VA 22314.)

Contd. . . . P/7

TABLE 3.3 Strength Properties of Selected Materials[1]

Material	Alloy	Ultimate Tensile Strength S_u (psi)	Yield Strength S_{yp} (psi)
Ultra-high-strength steel	AISI 4340	287,000	270,000
Stainless steel ([illegible] hardenable)	AM 350	206,000	173,000
High-carbon steel	AISI 1095	200,000	138,000
Graphite-epoxy composite		230,000	—
Titanium	Ti-6Al-4V	150,000	128,000
Cemented carbide	Tungsten carbide	134,000	—
[illegible]	[illegible]		
Nickel-base alloy	Inconel 601	102,000	50,000
Medium-carbon steel	AISI 1060 (HR)	98,000	54,000
	AISI 1060 (CD)	90,000	70,000
Low-carbon, low-alloy steel	AISI 4620 (HR)	87,000	63,000
	AISI 4620 (CD)	101,000	85,000
Stainless steel (austenitic)	AISI 304 (annealed)	85,000	35,000
Yellow brass	C 26800 (hard)	74,000	60,000
Commercial bronze	C 22000 (hard)	61,000	54,000
Low-carbon (mild) steel	AISI 1020 (CD)	61,000	51,000
	AISI 1020 (annealed)	57,000	43,000
	AISI 1020 (HR)	55,000	30,000

TABLE 3.13 Hardness of Selected Materials

	Hardness Scale[1]						
Material	BHN	R_C	R_A	R_B	R_M	V	Mohs
Diamond	8500 (approx.)[2]	—	—	—	—	—	10
Sapphire	—	—	—	—	—	—	9
Tungsten carbide	1850 (approx.)[2]	—	93	—	—	—	8–9
Titanium carbide	1850 (approx.)[2]	—	93	—	—	—	8–9
Case-hardened low-carbon steel	650	62	82.5	—	—	—	—
Ultra-high-strength steel	560	56	79	—	—	—	—
Titanium	315	34	67.5	—	—	—	—
Gray cast iron	262	26	—	—	—	—	—
Low-carbon low-alloy steel	207	15	—	—	—	—	—
Medium-carbon steel (CD)[3]	183	(9)[2]	—	89.5	—	—	—
Low-carbon steel (CD)	121	—	—	68	—	127	—
Aluminum (wrought)	120	—	—	67.5	—	126	—
Nickel-base alloy	114	—	—	64	—	120	—
Magnesium (extruded)	82	—	—	49	—	—	—
Commercial bronze	70	—	—	34	—	—	—
Gold (annealed)	—	—	—	—	—	25	—
Epoxy (glass reinforced)	—	—	—	—	105	—	—
Acrylic (cast)	—	—	—	—	85	—	—

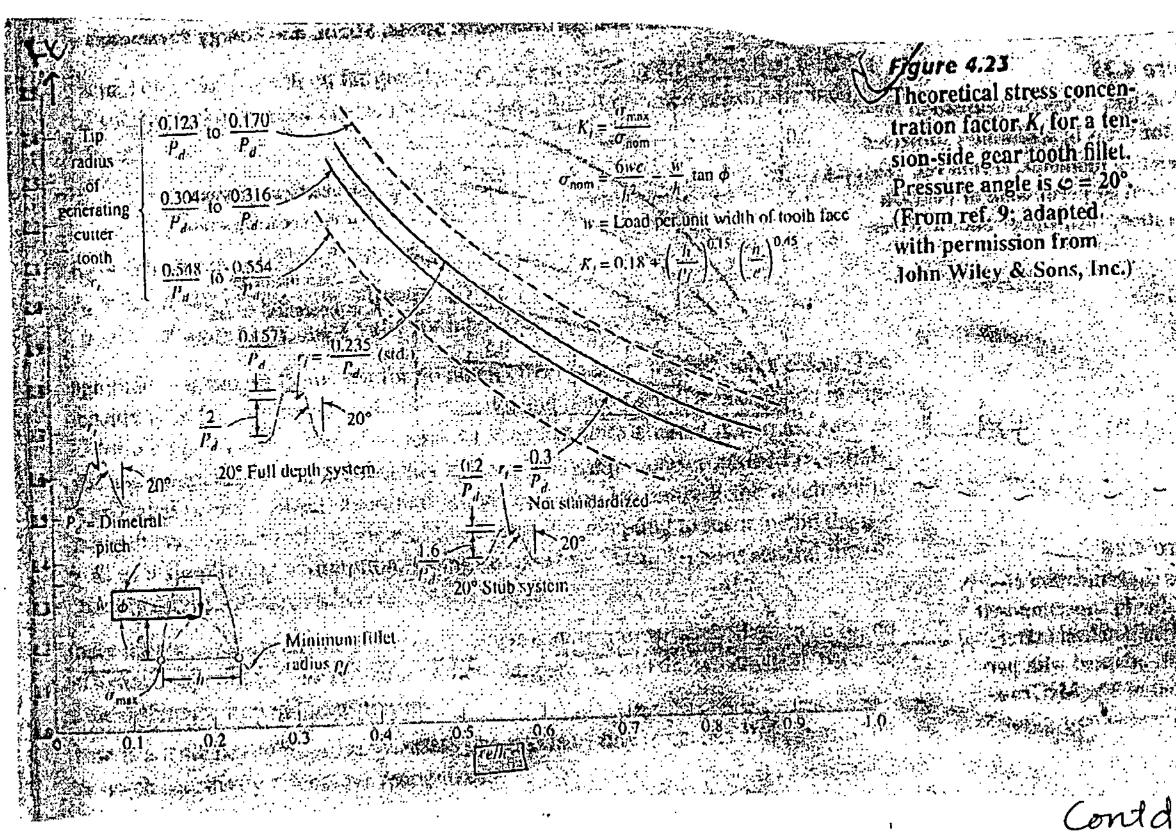

Figure 4.23 Theoretical stress concentration factor K_t for a tension-side gear tooth fillet. Pressure angle is $\phi = 20°$. (From ref. 9; adapted with permission from John Wiley & Sons, Inc.)

Contd ---- P/8

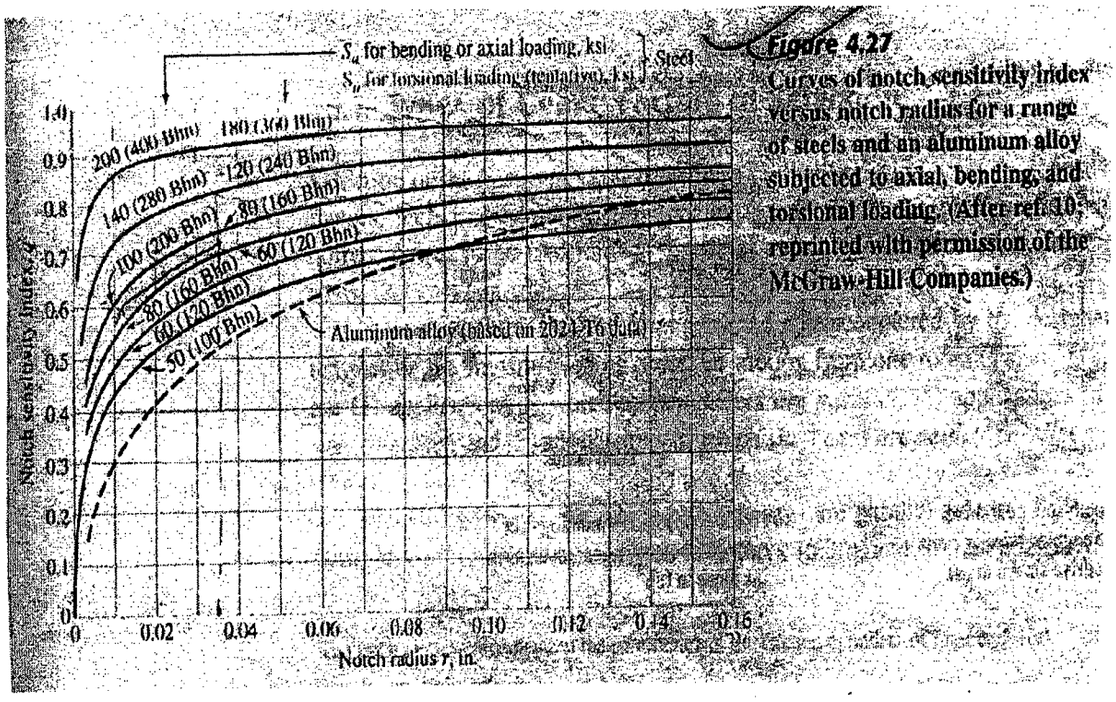

Figure 4.27 Curves of notch sensitivity index versus notch radius for a range of steels and an aluminum alloy subjected to axial, bending, and torsional loading. (After ref. 10, reprinted with permission of the McGraw-Hill Companies.)

TABLE 15.5 Values for Lewis Form Factor *Y* for 20° Full-Depth Involute Teeth

Number of Teeth	*Y*	Number of Teeth	*Y*
12	0.245	28	0.453
13	0.261	30	0.359
14	0.277	34	0.371
15	0.290	38	0.384
16	0.296	43	0.397
17	0.303	50	0.409
18	0.309	60	0.422
19	0.314	75	0.435
20	0.322	100	0.447
21	0.328	150	0.460
22	0.331	300	0.472
24	0.337	400	0.480
26	0.346	Rack	0.485

[41] Stress concentration was unknown at the time of the Lewis development for nominal stress in the root fillet.

TABLE 15.4 Accuracy Levels Typical of Various Gearing Applications

Accuracy Level	Dudley Designation[1]	Approximate *Standard Quality Ranges* AGMA[2] Q_v Value	DIN[3] Value
Highest possible accuracy. Achieved by special toolroom methods. Used for master gears, unusually critical high-speed gears, or when *both* highest load capacity and highest reliability are needed.	AA Ultra-high accuracy	14 or 15	2 or 3
High accuracy. Achieved by grinding or shaving with first-rate machine tools, and utilizing skilled operators. Widely used for turbine gearing and aerospace gearing. Sometimes used for critical industrial gears.	A High accuracy	12 or 13	4 or 5
Relatively high accuracy. Achieved by grinding or shaving with emphasis on production rate rather than highest quality. May be achieved by hobbing or shaping with best equipment under favorable conditions. Used for medium-speed industrial gears and critical vehicle gears.	B Medium-high accuracy	10 or 11	6 or 7
Good accuracy. Achieved by hobbing or shaping with first-rate machine tools and skilled operators. May be obtained in high-production grinding or shaving. Typically used for vehicle gears and electric motor industrial gears running at slower speeds.	C Medium accuracy	8 or 9	8 or 9

[42] Adapted from ref. 1. *Source:* Dudley Engineering Company, San Diego, CA.

L-3/T-2/IPE **Date : 12/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **IPE 315** (Operations Management)

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) Explain the functions of shop Floor control. **(10)**

   (b) Describe the terms 'make-to-order' and 'make-to-stock'. **(6)**

   (c) Discuss six basic differences between intermittent and mass production. **(12)**

   (d) Define time series. Explain the four components of time series. **(7)**

2. (a) Considering opinions of all employees, what qualitative forecasting techniques can be used? Which one is better and why? **(15)**

   (b) The number of transistors (in millions) made at a plant in Japan during the past 5 years are follows: **(20)**

Year	Transistors
1	140
2	160
3	190
4	200
5	210

   (i) Forecast the number of transistors to be made next year, using linear regression.

   (ii) Compute the mean absolute deviation.

3. (a) Explain effective lead time. For a production model, deduce an expression for the maximum inventory. **(15)**

   (b) Whole Nature Foods sells a gluten-free product for which the annual demand is 5000 boxes. At the moment it is paying $ 6.40 for each box; carrying cost is 25% of the unit cost, ordering costs are $25. A new supplier has offered to sell the same item for $6.00. If Whole Nature Foods buys at least 3000 boxes per order, should the firm stick with the old supplier, or take advantage of the new quantity discount?

4. (a) Define BOM. Explain in brief the required information for MRP calculation. **(10)**

   (b) **(25)**

Period (week	1	2	3	4	5	6	7	8	9	10	11	12
Gross requirements (unit)	30		40		30	70	20		10	80		50

   Holding cost = $ 2.50 / unit / week

   Setup cost = $ 150, Lead time = 1 week

   Beginning inventory = 40 units.

Contd P/2

IPE 315

Contd ... Q. No. 4

(i) Development a lot-for-lot solution and calculate total relevant costs for the data in the table.

(ii) Develop an EOQ solution and calculate total relevant cost for the data in the table.

SECTION – B

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

5. (a) What are the input and output capacity measures for the following operations: **(6)**

(i) Hospital

(ii) Theatre

(iii) University

(iv) Retail store

(v) Airline

(vi) Electricity company

(b) Prepare a worker-machine chart that describes activities and times needed to visit a bank and cash a check. **(6)**

(c) What are the main decision areas of job-shop scheduling? **(5)**

(d) A manager is trying to decide whether to purchase a certain part or to have it produced internally. Internal production could use either of the two processes. One would entail a variable cost of $17 per unit and an annual fixed cost of $200,000; the other would entail a variable cost of $14 per unit and an annual fixed cost of $240,000. Three vendors are willing to provide the part. Vendor A has a price of $20 per unit for any volume up to 30,000 units. Vendor B has a price of $22 per unit for demand of 1,000 units or less, and $18 per unit for larger quantities. Vendor C offers a price of $21 per unit for the first 1,000 units and $19 per unit for additional units. **(18)**

(i) If the manager anticipates an annual volume of 10,000 units, which any alternative would be best from a cost standpoint? For 20,000 units, which alternative would be best?

(ii) Determine the range for which each alternative is best. Are there any alternatives that are never best? Which?

6. (a) What are the alternative ways of coping with demand fluctuation? **(5)**

(b) Briefly discuss the advantages and disadvantages of each of the following planning strategies: **(12)**

(i) Maintain a level rate of output and let inventories absorb fluctuations in demand.

(ii) Vary the size of the workforce to correspond to predicted changes in demand requirements.

(iii) Maintain a constant workforce size, but vary hours worked to correspond to predicted demand requirements.

Contd P/3

IPE 315

Contd ... Q. No. 6

(c) Wormwood, Ltd. produces a variety of furniture products. The planning committee wants to prepare an aggregate plan for the next six months using the following information: **(18)**

	Month					
	1	2	3	4	5	6
Demand	160	150	160	180	170	140
Capacity						
Regular	150	150	150	150	160	160
Overtime	10	10	0	10	10	10

Cost Per Unit	
Regular time	$50
Overtime	75
Subcontract	80
Inventory per period	4

Subcontracting can handle a maximum of 10 units per month. Beginning inventory is zero. Develop a plan that minimizes total cost. No back orders are allowed.

7. (a) A large manufacturer of pencil sharpeners is planning to add a new line of sharpeners, and you have been asked to balance the process, given the following task times and precedence relationships. Assume that cycle time is to be the minimum possible. **(17)**

Task	Length (minutes)	Immediate follower
a	*0.2*	*b*
b	*0.4*	*d*
c	*0.3*	*d*
d	*1.3*	*g*
e	*0.1*	*f*
f	*0.8*	*g*
g	*0.3*	*h*
h	*1.2*	*end*

Contd P/4

IPE 315

Contd ... Q. No. 7

Do each of the following:

(i) Draw the precedence diagram.

(ii) Assign tasks to stations in order of greatest number of following tasks. Tiebreaker: greatest positional weight.

(iii) Determine the percentage of idle time.

(iv) Compute the rate of output that could be expected for this line assuming a 420-minute working day.

(v) What is the shortest cycle time that will permit use of only two workstations? Is this cycle time feasible?

(b) Explain the consequences of task time variability on line balancing. **(5)**

(c) A worker-machine operation was found to involve 3.3 minutes of machine time per cycle in the course of 40 cycles of stopwatch study. The worker's time averaged 1.9 minutes per cycle, and the worker was given a rating of 120 percent (machine rating is 100 percent). Midway through the study, the worker took a 10-minitue rest break. Assuming an allowance factor of 12 percent, determine the standard time for this job. **(8)**

(d) What are the primary uses of work sampling? **(5)**

8. (a) Define waste and mention types of waste to be eliminated. **(5)**

(b) Discuss the ways of ensuring a waste free production process. **(18)**

(c) Explain the Factor-rating system of the plant location techniques. **(12)**

Rektara 19.05.14

L-3/T-2/IPE **Date : 19/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **IPE 311** (Materials Handling and Maintenance Management)

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**.

Notations have their usual meaning.

1. (a) Define unit load and bulk load. Briefly discuss different technical factors for choosing conveying devices for unit loads and bulk loads. **(15)**

   (b) What is meant by lump size? Explain lump size calculation procedures for various bulk materials. **(10)**

   (c) Differentiate between static angle of repose and dynamic angle of repose. Is there any relation between resistance factor and efficiency of a conveying machine? Explain briefly. **(10)**

2. (a) Define capacity of a continuous conveying machine. How is it calculated for a conveyor carrying partially filled container? **(5)**

   (b) A belt conveyor is carrying wheat ($\gamma = 0.8$ ton/m^3 and $\varphi_{dyn} = 25^o$) at a speed of 0.75 m/s. Calculate load per meter and capacity. Assume width of the belt is 1 m with 0.1 m clearance each side. **(15)**

   (c) A powered roller conveyor is carrying unit load of 50 kg at a speed of 0.5 m/sec. If capacity is 5000 units/shift. Calculate space between two loads, time interval between units and load per meter. **(15)**

3. (a) Discuss relative advantages and disadvantages of belt conveyor over apron conveyor. **(8)**

   (b) Classify belts employed in belt conveyors. What kind of belt is generally preferred? Why? Briefly explain different rubberized textile belt with neat sketches of their cross sections. **(15)**

   (c) Explain typical drive arrangements for belt conveyors. Provide necessary figures. Also compare geometry of belt conveyors and apron conveyors. **(12)**

4. (a) With neat sketches discuss various unpowered rollers. **(5)**

   (b) Derive the equations of the following items for powered roller conveyor: **(12)**

   (i) Motor rating

   (ii) Maximum torque transmitted to rollers.

   (c) What are the main applications of bucket elevators and screw conveyors. A horizontal screw conveyor is to be designed to convey moulding sand ($\gamma = 1.65$ ton/m^3); required capacity, Q = 35 ton/hr and conveying length, L = 20 m. Assume $\Psi = 0.125$, n = 37.5 rpm, $w_o = 4$ and $\eta_g = 0.9$. Determine (i) Motor power (ii) Torque transmitted by the motor (iii) Load propulsion rate (iv) Load per meter and (v) Axial force along the screw. **(18)**

Contd P/2

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SECTION – B

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

5. (a) What are the objectives of maintenance? Briefly explain the goals of Total Productivity Maintenance (TPM). **(8)**

(b) Explain the terms: **(12)**

(i) Reliability performance

(ii) Maintenance support performance and

(iii) Maintainability performance

(c) Explain LLC with neat sketch of bath tub curve. Discuss influence of LLC in purchasing capital machineries. **(15)**

6. (a) What is failure? Classify and explain preventive and corrective maintenances. **(13)**

(b) Why and how maintenance engineering should always try to get unplanned repair jobs planned. **(12)**

(c) Discuss how failure frequency changes with breakdown maintenance, preventive maintenance, corrective maintenance and predictive maintenance. **(10)**

7. (a) Explain the terms OTBD, FTM, CBM, DOM, LTE and RED. **(12)**

(b) Loucks Manufacturing Company operates its 23 large and expensive grinding and lathe machines from 7 AM to 11 PM, seven days a week. For the past year the firm has been under contract with Simkin and Sons for daily preventive maintenance (lubrication, cleaning, inspection, and so on). Simkin's crew works between 11 PM and 2 AM so as not to interfere with the daily manufacturing crew. Simkin charges $645 per week for this service. Since signing the maintenance contract, Loucks Manufacturing has noted an average of only three breakdowns per week. When a grinding or lathe machine does break down during a working shift, it costs Loucks about $250 in lost production and repair costs. **(23)**

After reviewing past breakdown records (for the periods before signing a preventive maintenance contract with Simkin and Sons), Loucks Manufacturing's production manager summarized the patterns shown below.

The production manager is not certain that the contract for preventive maintenance with Simkin is in the best financial interest of Lucks Manufacturing. He recognizes that much of his breakdown data is old but is fairly certain that it is representative of the present picture.

What is your analysis of this situation and what recommendations do you think the production manager should make?

Contd P/3

IPE 311

Number of Breakdown Pre Week	Number of Weeks in which Breakdowns Occurred
0	1
1	1
2	3
3	5
4	9
5	11
6	7
7	8
8	5
Total weeks of historical data:	50

8. (a) What are the main objectives for factory layout design? Briefly explain fixed position layout and hybrid layout with suitable examples. **(10)**

(b) Consider the existing layout of Recovery First Sports Medical Clinic given below. Trips between departments and REL chart of the Clinic is available in Fig. for Q. 8(b). Propose two improved layout based on process layout design principles. **(25)**

A Radiology	B Laboratory	C Lobby & Waiting
D Examining Rooms	E Surgery & Recovery	F Physical Therapy
