L-3/T-2/ME **Date : 11/07/2011**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2009-2010

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**.

1. (a) A die is loaded in such a way that, number 1, 2, 3 are twice likely to occur than number 4, 5, 6. If the die is rolled twice, what is the probability of getting 2 odd numbers or two even numbers? **(10)**

(b) The total number of hours, measured in units of 100 hours, that a family runs vacuum cleaner over a period of one year is a continuous random variable X that has the density function: **(10)**

$$F(x) = \begin{cases} x & ; \ 0 < x1 \\ 2-x & ; \ 1 \le x < 2 \\ 0 & ; \ elsewhere \end{cases}$$

(i) Find the Cumulative Distribution Function F(x)

(ii) Draw F(x) with respect to x.

(iii) Find the probability that over a period of one year, a family runs their vacuum cleaner less that 120 hours.

(c) Explain with neat sketch the working principle of an autocollimator and pivoted stylus to measure the diameter of a bore. Derive the expression for bore diameter and find the probable amount of error in calculation for, **(15)**

R = 50 mm ± 0.01 mm

$\alpha = 10^\circ \pm 0.01'$

$\beta = 9^\circ \pm 0.1'$

Where the symbols carry the usual meanings.

2. (a) The output voltage of certain electric circuit is specified to be 131. If the voltage falls as low as 130, serious consequences may result. In a given period, 40 independent readings on the voltage are to be taken. For testing $H_0 : \mu \ge 131$ versus $Ha : \mu = 130$, Significance level, α is to be 0.05. If the standard deviation, σ = 1.9 volt for these circuit, calculate the probability of Type-I and Type-II Error. **(10)**

(b) The following data show the frequency counts for 380 observations on the number of bacterial colonies within the field of a microscope. **(15)**

Contd P/2

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Contd ... Q. No. 2(b)

Number of colonies per field	Frequency of observations
0	56
1	104
2	80
3	62
4	42
5	27
6	9

Test the hypothesis that, the data fit the poisson distribution. Here λ is the average number of colonies per field. Use Significance level, $\alpha = 0.05$.

(c) What is a best size wire? What are the advantages of using best size wire to measure effective diameter of a screw thread? Derive the expression of effective diameter of a screw thread using best size wire. **(10)**

3. (a) Define involute and cycloidal profile of gear? Derive expression for Involute function. **(8)**

(b) What do you understand by interchangeable manufacturing and why is it important? **(6)**

(c) What is the significance of Chebyshev's theorem in statistical application? **(6)**

(d) Explain the following types of measurement errors that likely to creep in precision measurement: **(15)**

(i) Contact point penetration
(ii) Effect of alignment
(iii) Error due to poor contact.

4. (a) What do you understand by Moment Generating Function? Derive the expression of Moment Generating Function for Binomial and Geometric distribution. **(10)**

(b) With relevant sketch explain the following criteria to design a limit gauges: **(10)**

(i) Allocation of tolerance.
(ii) Fixing gauge element with handles.

(c) What do you understand by kinematic accuracy of a gear? What is the basic difference between gear reproducing method and gear generating method? What are the sources of error in these two gear manufacturing method? **(10)**

(d) Why a screw thread is more prone to error than a plain shaft? What problem may arise due to error in screw thread? **(05)**

Contd P/3

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SECTION – B

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

5. (a) "TQM reflects a different way of viewing the entire way of life of the people in the organization" — Do you agree with this statement? Justify your answer. **(11)**

(b) Explain the stages of PDCA cycle which one must go through to get from 'problem faced' to 'problem solved'. **(12)**

(c) How does the concept of 'zero defect' not economically beneficial according to Juran's Model? Is it possible to achieve minimum cost at the point of 100% good quality? Discuss briefly. **(12)**

6. (a) How does BPR differ from TQM? What are the risks and barriers to BPR? **(10)**

(b) The production of integrated circuits by etching them onto silicon wafers requires silicon wafers of consistent thickness. However their customer has raised questions about whether or not the process is capable of producing wafers within their specifications of 0.250 mm ± 0.005. Using the data provided in the Table-1, **(25)**

(i) Draw $\overline{X} - R$ chart to find out whether the process is in good control or not.

(ii) Calculate the process potential index and process performance index.

(iii) Interpret the indices.

(iv) Find out the total fraction of products not meeting specifications.

(v) Process Capability Ratio.

Table - 1 : Silicon Wafer Thickness

Subgroup	Thickness of silicon wafers for four observations			
1	0.2500	0.2510	0.2490	0.2500
2	0.2510	0.2490	0.2490	0.2520
3	0.2510	0.2510	0.2490	0.2480
4	0.2490	0.2470	0.2520	0.2480
5	0.2500	0.2470	0.2500	0.2520
6	0.2510	0.2520	0.2490	0.2410
7	0.2510	0.2480	0.2500	0.2500
8	0.2500	0.2490	0.2490	0.2520
9	0.2500	0.2470	0.2500	0.2510
10	0.2480	0.2480	0.2510	0.2530
11	0.2500	0.2500	0.2500	0.2530
12	0.2510	0.2490	0.2510	0.2540
13	0.2500	0.2470	0.2500	0.2510
14	0.2500	0.2500	0.2490	0.2520
15	0.2500	0.2470	0.2500	0.2510

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7. (a) The basic QFD methodology involves four basic phases – Explain each phases with appropriate example. **(12)**

(b) A company and its customer have agreed to follow a double sampling plan with the following parameters : **(15)**

lot size = 3000,

First sample size = 40, Acceptance No. = 2

Second sample size = 80, Acceptance No. = 4

For fraction non conforming value 0.05,

Find out the total probability of acceptance in the combined sample.

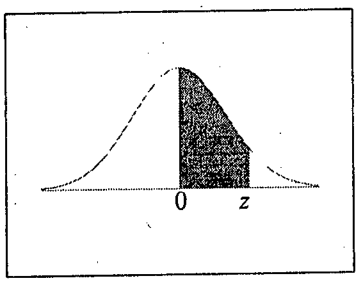
(c) 'Quality appraisal means quality evaluation' – Justify this statement. **(8)**

8. (a) Which parameters of a gear is tested using Parkinson Gear Tester? Discuss the working principle of a Parkinson Gear Tester explaining how it is used to test the gear. **(12)**

(b) Does tooth eccentricity effects pitch error in a gear? If yes, explain the effect from different point of gear performance. **(13)**

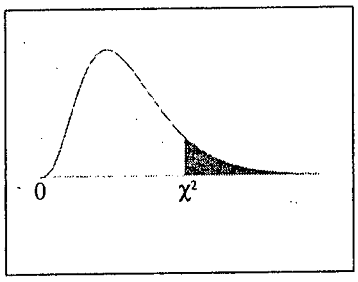
(c) Explain how Barrel Tumbling is used for surface finish. What are the purposes of using it? **(10)**

Standard Normal Distribution Table



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998

Chi-Square Distribution Table



The shaded area is equal to α for $\chi^2 = \chi^2_\alpha$.

df	$\chi^2_{.995}$	$\chi^2_{.990}$	$\chi^2_{.975}$	$\chi^2_{.950}$	$\chi^2_{.900}$	$\chi^2_{.100}$	$\chi^2_{.050}$	$\chi^2_{.025}$	$\chi^2_{.010}$	$\chi^2_{.005}$
1	0.000	0.000	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

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

Sample size n	$\overline{X}$ charts: Factors for control limits			S charts: Factors for central line	S charts: Factors for control limits				R charts: Factors for central line	R charts: 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

L-3/T-2/ME **Date : 23/07/2011**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2009-2010

Sub : **ME 343** (Machine 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**.

The students may use "Machine Design Handbook–II". Assume reasonable value for missing data if there is any. The Symbols have their usual meanings.

1. A 50 mm × 50 mm ring-oiled full sleeve bearing is lubricated with SAE 40 oil at an inlet temperature of 38°C and supports a radial load of 5 kN. The bearing has a journal speed of 1500 rev/min and a radial clearance of 50 μm. The bearing is medium construction (A = 20 dl) and operating in still air. Determine **(35)**
   (a) oil average temperature
   (b) coefficient of friction
   (c) magnitude of minimum oil film thickness
   (d) total flow and side flow
   (e) maximum oil film pressure
   (f) frictional loss in bearing
   (g) heat dissipation to the surroundings.

2. The worm in a worm gear set is coupled to an electric motor, which rotates at 1500 rpm and delivers 15 kW of power. Decide upon the module, face width, pitch circle diameter of the gear assuming normal pressure angle, $\phi_n = 20^\circ$, velocity ratio, m_w = 25, number of starts, N_w = 4. Choose high test C.I for the worm and bronze for the gear. Consider the limiting endurance strength of bronze as 168 MPa. **(35)**

3. A skip for a mine shaft weights 1 ton and is to lift a maximum load of 1.5 ton from a depth of 250 m. The maximum speed of 7.5 m/s is to be attained in 6 s. **(35)**
   (a) What size of 6 × 37 IWRC, IPS rope and sheave should be used based on the design on static condition considering factor of safety of 7.0.
   (b) Determine the factor of safety of the rope size in (a) on the basis of fatigue for indefinite life.
   (c) Find also the size of the rope based on the design of fatigue condition for a definite life of 0.2 million cycle considering safety factor of 1.3.

Contd P/2

4. (a) A ground finished shaft with a sled runner keyway is subjected to a completely reversed bending moment of 3500 N.m. The shaft transmits 60 kW at 250 rpm. The material is AISI 4130, WQT 540°C. Consider fatigue strength reduction factor of 1.6 for the keyway and a reliability factor of 0.868 for 95% reliability. Choose safety factor of 1.3 based on DE-elliptical model. Determine the shaft diameter. **(20)**

(b) A helical gear has 40 teeth and a pitch diameter of 260 mm. The gear has normal module of 6 and the pressure angle in the plane of rotation is 21.52°. The force normal to the tooth surface is 4 kN. Determine the power transmitted at 600 rpm and the virtual number of teeth. **(15)**

SECTION – B

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

5. The 20° full-depth teeth for a pair of steel gears are to transmit 30 kW with 1000 rpm of the 20 teeth pinion: mg = 3, continuous service and indefinite life. The driven machine is an off and on reciprocating compressor. Determine the face width, module and the type of steel material with its heat treatment. **(35)**

6. A coiled compression spring is to fit inside a cylinder 20 mm in diameter. For one position of the piston, the spring is to exert a pressure on the piston equivalent of 35 kPa of piston area and in this position the overall length of the spring must not exceed 60 mm. A pressure of 300 kPa on the piston is to compress the spring 20 mm from the position described above. Design a spring for medium service. Specify suitable material, number of total and active coils for squard and ground ends. **(35)**

7. (a) A 2 m long cylindrical pressure vessel with inner diameter of 0.9 m is subjected to an internal gauge pressure of 1 MPa. The vessel operates at room temperature and curing residual stresses are neglected. The cylinder is made of 45° graphite/epoxy lamine. Determine the thickness of the vessel and number of laminae using the information as follows: **(15)**

   (i) thickness of each lamine is 0.13 mm
   (ii) fibre volume fraction of lamina is 70%
   (iii) factor of safety is 1.95
   (iv) use Tsai- Hill failure criteria.

   (b) A shaft rotating at 500 rpm have radial load of 1.5 kN is to be filled with ball bearing. The design life of the bearing is 20 hr with 0.5% probability of failure. Choose a bearing. **(17)**

8. A 24 hr service centrifugal pump running at 350 rpm consumes 75 kW, is to be driven by a compensator started motor of 90 kW with 1400 rpm. The center distance between the pulleys is 1.0 m to 1.2 m. Determine the details of a multiple V-belt drive for this installation. **(35)**

L-3/T-2/ME **Date : 30/07/2011**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2009-2010

Sub : **ME 303** (Convection, Boiling, Condensation and Mass Transfer)

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**.

Assume any missing data with reasonable accuracy.

1. (a) Name the factors that one should consider during design of a modern heat exchanger and discuss. **(7)**

(b) A heat exchanger is to be designed to cool an ethyl alcohol solution from 75°C to 45 °C with cooling water entering the tube at 15°C. The overall heat transfer coefficient based on the outer tube surface area $u_0 = 500\ W/m^2\ {}^oC$. Making necessary assumptions calculate the heat transfer surface area for each of the following flow arrangements: **(21)**

(i) parallel flow, shell and tube
(ii) counterflow, shell and tube
(iii) one shell pass two tube pass
(iv) cross-flow, both fluids unmixed

Assume the following information:

mass flow rate of ethyl alcohol:	8.7 kg/sec
specific heat of ethyl alcohol:	3840 J/kg °C
mass flow rate of cooling water:	9.6 kg/sec
specific heat of water:	4180 J/kg °C.

(c) Define effectiveness of heat exchanger. Discuss the application of ε-NTU method for heat exchanger analysis. **(7)**

2. (a) Distinguish between film-wise and drop-wise condensation. In which case you will expect more heat-flux and why? **(7)**

(b) Calculate the average heat transfer coefficient for film-wise condensation of Pure steam at atmospheric pressure for **(28)**

(i) a vertical surface of 1.5 meter in length.
(ii) the outside-surface of a vertical tube of 1.5 cm OD and 1.5 meter in length.
(iii) the outside surface of a horizontal tube 1.5 cm OD and 1.5 meter in length.
(iv) Discuss your findings that you have obtained.

In all cases, assume that the surface temperatures are constant at 30°C below the saturation temperature. The following properties of the condensate may be assumed:

$k_e = 0.64\ w/m^\circ C$ $\rho_e = 995\ kg/m^3$ $h_{fg} = 2400\ kJ/kg$

$\rho_v \approx 0$ $\mu_e = 0.562 \times 10^{-3}\ kg/m\text{-}sec$

Contd P/2

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3. (a) Give a neat sketch of a typical Pool boiling curve for a tube surface in a Pool of water at atmospheric pressure. Describe the influence of different factors affecting the nucleate boiling heat transfer. **(15)**

(b) Make differences between nucleate and film boiling. Why does radiation heat transfer play a significant role in film boiling heat transfer? **(10)**

(c) How is heat transfer coefficient in forced-convection boiling calculated? Describe. **(10)**

4. (a) Define mass transfer coefficient. 'In equimolar counter diffusion of two gases the partial pressure gradients must be equal in magnitude but opposite in direction.' Explain. **(8)**

(b) Dry air at atmospheric pressure blows across a thermometer which is enclosed in a dampened cover. The thermometer reads a temperature of t_W. Using the relation between heat and mass transfer derive an expression for determination of the temperature of the dry air. **(12)**

(c) Write short notes on any three of the followings: **(15)**

(i) Boundary layer film thickness in condensation (ii) Shell and tube heat exchanger condensation (iii) Critical heat flux (iv) Boiling heat transfer at low gravity (v) Fouling of heat exchanger (vi) Isothermal evaporation of water from a surface.

SECTION – B

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

Symbols have their usual meaning. Assume reasonable values for missing data, if any.

5. (a) What do you mean by the hydrodynamic and the thermal boundary layer over a flat plate? Show different regions in those boundary layers with their velocity and temperature profiles. **(7)**

(b) Using dimensional analysis, show that for forced convection heat transfer over a flat plate, $Nu = f(\text{Re}, \text{Pr})$. **(10)**

(c) A flat plate 1 m wide and 1.5 m long, is maintained at 90°C in air with free stream temperature of 10°C flowing along 1.5 m side of the plate. Determine the velocity of the air required to have a rate of heat dissipation of 3.75 kW. Following correlations may be used: **(18)**

$Nu_L = 0.664\,\text{Re}^{1/2}\,\text{Pr}^{1/3}$ .... for laminar flow

$Nu_L = \left[0.036\,\text{Re}^{0.8} - 836\right]\text{Pr}^{1/3}$ .... for turbulent flow.

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6. (a) Define developing flow and fully developed flow inside a circular pipe. What is entry zone? **(5)**

(b) For a forced convection case inside a tube prove that $st = \frac{f}{8}$. **(12)**

(c) Wate flows with a mean velocity of 2 m/s inside a circular pipe of inside diameter of 50 mm. The pipe wall is maintained at a uniform temperature of 100°C. At a location where the flow is hydrodynamically and thermally developed, the bulk mean temperature is 60°C. Calculate the heat transfer coefficient by using: **(18)**

Gnielinsky Correlation:

$$Nu_D = \frac{(f/2)(\mathrm{Re}_D - 1000)\,\mathrm{Pr}}{1 + 12.7\,(f/2)^{1/2}\left(\mathrm{Pr}^{2/3} - 1\right)}$$

Assume, the friction factor, f = 0.0205. Take properties at bulk mean temperature.

7. (a) Draw the temperature and the velocity distribution in the vicinity of a heated flat plate placed vertically in still air. **(12)**

(b) Define Grashof number. Explain its physical significance. **(5)**

(c) A vertical plate of height 5 m and width 1.5 m has one of its surfaces insulated. The other surface is maintained at a uniform temperature of 400 K. This surface is exposed to quiescent atmospheric air at 300 K. Calculate the total rate of heat loss from the plate. **(18)**

For natural convection over a vertical flat surface:

$$\overline{Nu_L} = 0.68 + \frac{0.670\,Ra_L^{1/4}}{\left[1 + (0.492/\mathrm{Pr})^{9/16}\right]^{4/9}} \quad ; \quad \text{for } Ra_L \le 10^9$$

$$\overline{Nu_L} = \left\{0.825 + \frac{0.387\,Ra_L^{1/6}}{\left[1 + (0.492/\mathrm{Pr})^{9/16}\right]^{8/27}}\right\} \quad ; \quad \text{for } 10^9 < Ra_L < 10^{12}$$

8. (a) Explain the physical significance of the Reynolds number and the Rayleigh number in relation to the forced and free convection heat transfer. **(8)**

(b) Derive the two-dimensional, steady state energy equation in Cartesian coordinate system. Under what condition does energy equation reduce to a simple conduction equation? **(20)**

(c) Explain the physical significance of Nusselt number and Prandtl number in relation to heat transfer. **(7)**

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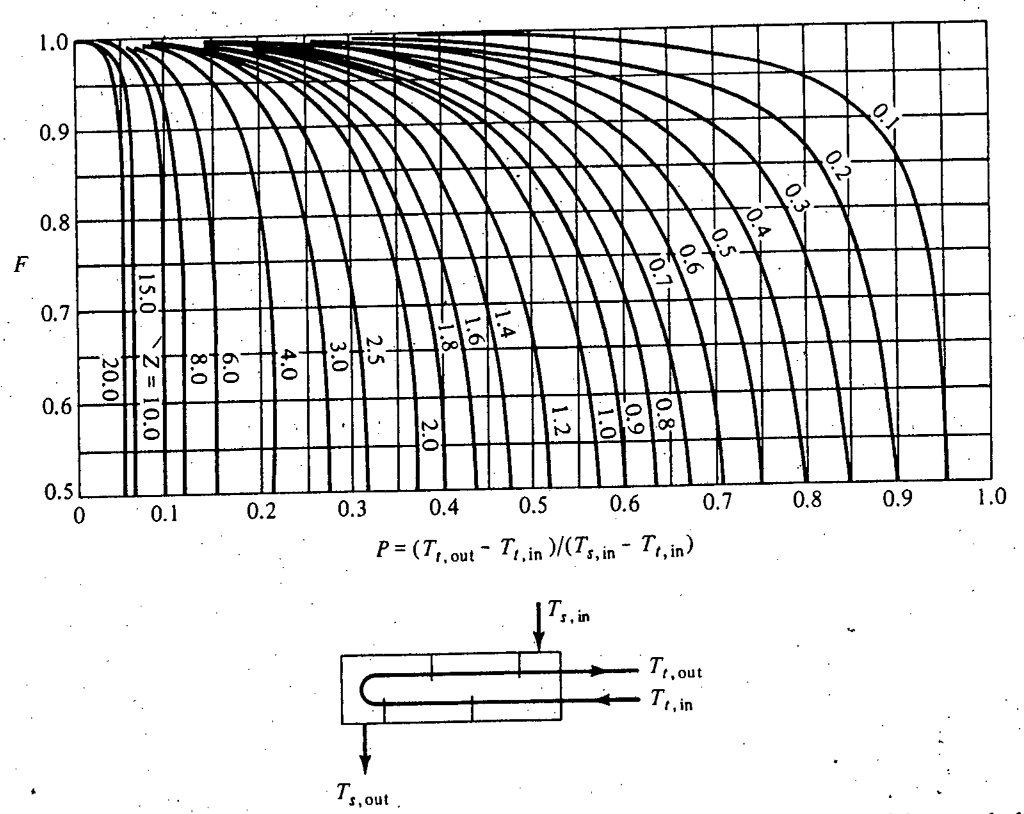

Figure 8.12 Correction factor to counterflow LMTD for heat exchanger with one shell pass and two, or a multiple of two, tube passes. (Courtesy of the Tubular Exchange Manufacturers Association.)

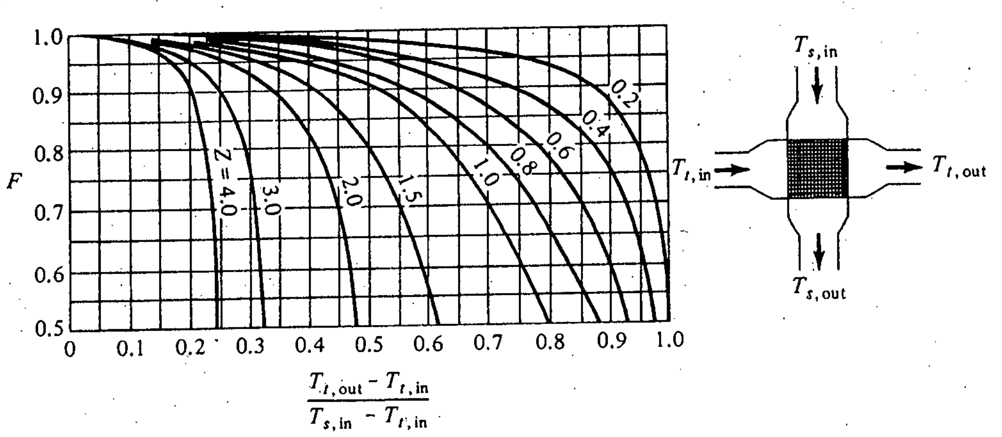

Figure 8.15 Correction factor to counterflow LMTD for a cross-flow heat exchanger with both fluids unmixed and one tube pass. [Extracted from R. A. Bowman, A. C. Mueller, and W. M. Nagel (7); with permission of the publishers, the American Society of Mechanical Engineers.)

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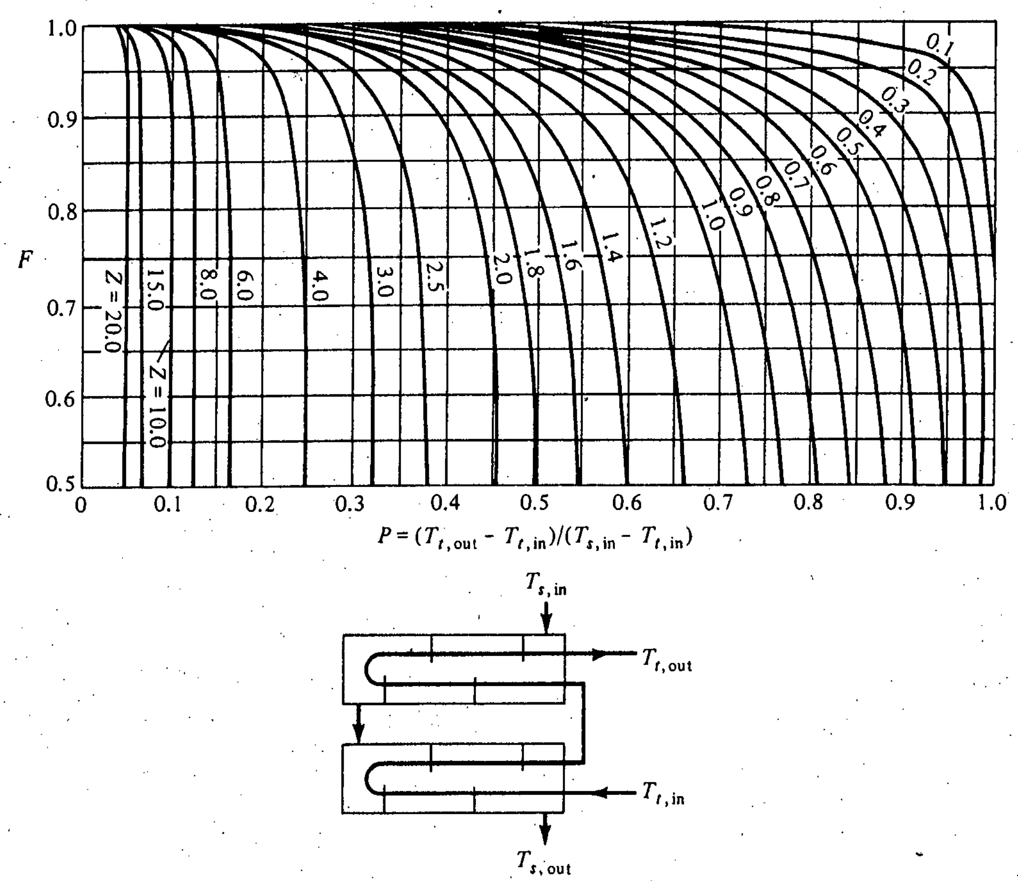

Figure 8.13 Correction factor to counterflow LMTD for heat exchanger with two shell passes and a multiple of two tube passes. (Courtesy of the Tubular Exchange Manufacturers Association.)

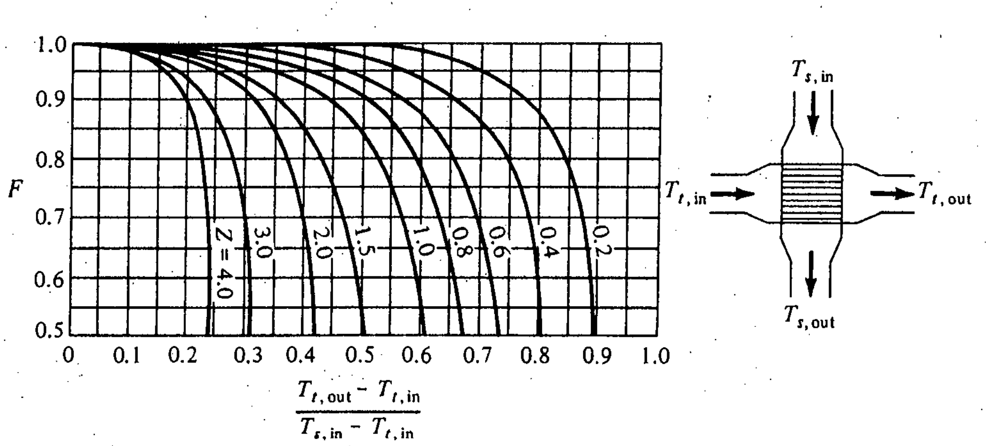

Figure 8.14 Correction factor to counterflow LMTD for cross-flow heat exchangers with the fluid on the shell side mixed, the other fluid unmixed, and one tube pass. [Extracted from R. A. Bowman, A. C. Mueller, and W. M. Nagel (7), with permission of the publishers, the American Society of Mechanical Engineers.]

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The heat-transfer coefficient is now written

$$h\,dx\,(T_w - T_g) = -k\,dx\,\frac{T_g - T_w}{\delta}$$

or

$$h = \frac{k}{\delta}$$

so that

$$h_x = \left[\frac{\rho(\rho - \rho_v)gh_{fg}k^3}{4\mu x(T_g - T_w)}\right]^{1/4} \tag{9-7}$$

Expressed in dimensionless form in terms of the Nusselt number, this is

$$\mathrm{Nu}_x = \frac{hx}{k} = \left[\frac{\rho(\rho - \rho_v)gh_{fg}x^3}{4\mu k(T_g - T_w)}\right]^{1/4} \tag{9-8}$$

The average value of the heat-transfer coefficient is obtained by integrating over the length of the plate:

$$\bar{h} = \frac{1}{L}\int_0^L h_x\,dx = \tfrac{4}{3}h_{x=L} \tag{9-9}$$

or

$$\bar{h} = 0.943\left[\frac{\rho(\rho - \rho_v)gh_{fg}k_f^3}{L\mu_f(T_g - T_w)}\right]^{1/4} \tag{9-10}$$

More refined analyses of film condensation are presented in detail by Rohsenow [37]. The most significant refinements take into account a nonlinear temperature profile in the film and modifications to the energy balance to include additional energy to cool the film below the saturation temperature. Both effects can be handled by replacing h_{fg} with h'_{fg}, defined by

$$h'_{fg} = h_{fg} + 0.68c(T_g - T_w) \tag{9-11}$$

where c is the specific heat of the liquid. Otherwise, properties in Eqs. (9-7) and (9-10) should be evaluated at the film temperature

$$T_f = \frac{T_g + T_w}{2}$$

With these substitutions Eq. (9-10) may be used for vertical plates and cylinders and fluids with $\mathrm{Pr} > 0.5$ and $cT/h_{fg} \le 1.0$.

For laminar film condensation on horizontal tubes Nusselt obtained the relation

$$\bar{h} = 0.725\left[\frac{\rho(\rho - \rho_v)gh_{fg}k_f^3}{\mu_f d(T_g - T_w)}\right]^{1/4} \tag{9-12}$$

where d is the diameter of the tube. When condensation occurs on a horizontal tube bank with n tubes placed directly over one another in the vertical direction, the heat-transfer coefficient may be calculated by replacing the diameter in Eq. (9-12) with nd.

When a plate on which condensation occurs is sufficiently large or there is a sufficient amount of condensate flow, turbulence may appear in the

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TABLE A.4 Thermophysical Properties of Gases at Atmospheric Pressure[a]

T (K)	ρ (kg/m³)	c_p (kJ/kg · K)	$\mu \cdot 10^7$ (N · s/m²)	$\nu \cdot 10^6$ (m²/s)	$k \cdot 10^3$ (W/m · K)	$\alpha \cdot 10^6$ (m²/s)	Pr
Air							
100	3.5562	1.032	71.1	2.00	9.34	2.54	0.786
150	2.3364	1.012	103.4	4.426	13.8	5.84	0.758
200	1.7458	1.007	132.5	7.590	18.1	10.3	0.737
250	1.3947	1.006	159.6	11.44	22.3	15.9	0.720
300	1.1614	1.007	184.6	15.89	26.3	22.5	0.707
350	0.9950	1.009	208.2	20.92	30.0	29.9	0.700
400	0.8711	1.014	230.1	26.41	33.8	38.3	0.690
450	0.7740	1.021	250.7	32.39	37.3	47.2	0.686
500	0.6964	1.030	270.1	38.79	40.7	56.7	0.684
550	0.6329	1.040	288.4	45.57	43.9	66.7	0.683
600	0.5804	1.051	305.8	52.69	46.9	76.9	0.685
650	0.5356	1.063	322.5	60.21	49.7	87.3	0.690
700	0.4975	1.075	338.8	68.10	52.4	98.0	0.695
750	0.4643	1.087	354.6	76.37	54.9	109	0.702
800	0.4354	1.099	369.8	84.93	57.3	120	0.709
850	0.4097	1.110	384.3	93.80	59.6	131	0.716
900	0.3868	1.121	398.1	102.9	62.0	143	0.720
950	0.3666	1.131	411.3	112.2	64.3	155	0.723
1000	0.3482	1.141	424.4	121.9	66.7	168	0.726
1100	0.3166	1.159	449.0	141.8	71.5	195	0.728
1200	0.2902	1.175	473.0	162.9	76.3	224	0.728
1300	0.2679	1.189	496.0	185.1	82	238	0.719
1400	0.2488	1.207	530	213	91	303	0.703
1500	0.2322	1.230	557	240	100	350	0.685
1600	0.2177	1.248	584	268	106	390	0.688
1700	0.2049	1.267	611	298	113	435	0.685
1800	0.1935	1.286	637	329	120	482	0.683
1900	0.1833	1.307	663	362	128	534	0.677
2000	0.1741	1.337	689	396	137	589	0.672
2100	0.1658	1.372	715	431	147	646	0.667
2200	0.1582	1.417	740	468	160	714	0.655
2300	0.1513	1.478	766	506	175	783	0.647
2400	0.1448	1.558	792	547	196	869	0.630
2500	0.1389	1.665	818	589	222	960	0.613
3000	0.1135	2.726	955	841	486	1570	0.536

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TABLE A.6 Thermophysical Properties of Saturated Water[a]

Temperature, T (K)	Pressure, P (bars)[b]	Specific Volume (m³/kg) $v_f \cdot 10^3$	v_g	Heat of Vaporization, h_{fg} (kJ/kg)	Specific Heat (kJ/kg · K) $c_{p,f}$	$c_{p,g}$	Viscosity (N · s/m²) $\mu_f \cdot 10^6$	$\mu_g \cdot 10^6$	Thermal Conductivity (W/m · K) $k_f \cdot 10^3$	$k_g \cdot 10^3$	Prandtl Number Pr_f	Pr_g	Surface Tension, $\sigma_f \cdot 10^3$ (N/m)	Expansion Coefficient, $\beta_f \cdot 10^6$ (K⁻¹)
273.15	0.00611	1.000	206.3	2502	4.217	1.854	1750	8.02	569	18.2	12.99	0.815	75.5	−68.05
275	0.00697	1.000	181.7	2497	4.211	1.855	1652	8.09	574	18.3	12.22	0.817	75.3	−32.74
280	0.00990	1.000	130.4	2485	4.198	1.858	1422	8.29	582	18.6	10.26	0.825	74.8	46.04
285	0.01387	1.000	99.4	2473	4.189	1.861	1225	8.49	590	18.9	8.81	0.833	74.3	114.1
290	0.01917	1.001	69.7	2461	4.184	1.864	1080	8.69	598	19.3	7.56	0.841	73.7	174.0
295	0.02617	1.002	51.94	2449	4.181	1.868	959	8.89	606	19.5	6.62	0.849	72.7	227.5
300	0.03531	1.003	39.13	2438	4.179	1.872	855	9.09	613	19.6	5.83	0.857	71.7	276.1
305	0.04712	1.005	29.74	2426	4.178	1.877	769	9.29	620	20.1	5.20	0.865	70.9	320.6
310	0.06221	1.007	22.93	2414	4.178	1.882	695	9.49	628	20.4	4.62	0.873	70.0	361.9
315	0.08132	1.009	17.82	2402	4.179	1.888	631	9.69	634	20.7	4.16	0.883	69.2	400.4
320	0.1053	1.011	13.98	2390	4.180	1.895	577	9.89	640	21.0	3.77	0.894	68.3	436.7
325	0.1351	1.013	11.06	2378	4.182	1.903	528	10.09	645	21.3	3.42	0.901	67.5	471.2
330	0.1719	1.016	8.82	2366	4.184	1.911	489	10.29	650	21.7	3.15	0.908	66.6	504.0
335	0.2167	1.018	7.09	2354	4.186	1.920	453	10.49	656	22.0	2.88	0.916	65.8	535.5
340	0.2713	1.021	5.74	2342	4.188	1.930	420	10.69	660	22.3	2.66	0.925	64.9	566.0
345	0.3372	1.024	4.683	2329	4.191	1.941	389	10.89	668	22.6	2.45	0.933	64.1	595.4
350	0.4163	1.027	3.846	2317	4.195	1.954	365	11.09	668	23.0	2.29	0.942	63.2	624.2
355	0.5100	1.030	3.180	2304	4.199	1.968	343	11.29	671	23.3	2.14	0.951	62.3	652.3
360	0.6209	1.034	2.645	2291	4.203	1.983	324	11.49	674	23.7	2.02	0.960	61.4	697.9
365	0.7514	1.038	2.212	2278	4.209	1.999	306	11.69	677	24.1	1.91	0.969	60.5	707.1
370	0.9040	1.041	1.861	2265	4.214	2.017	289	11.89	679	24.5	1.80	0.978	59.5	728.7
373.15	1.0133	1.044	1.679	2257	4.217	2.029	279	12.02	680	24.8	1.76	0.984	58.9	750.1
375	1.0815	1.045	1.574	2252	4.220	2.036	274	12.09	681	24.9	1.70	0.987	58.6	761
380	1.2869	1.049	1.337	2239	4.226	2.057	260	12.29	683	25.4	1.61	0.999	57.6	788
385	1.5233	1.053	1.142	2225	4.232	2.080	248	12.49	685	25.8	1.53	1.004	56.6	814
390	1.794	1.058	0.980	2212	4.239	2.104	237	12.69	686	26.3	1.47	1.013	55.6	841
400	2.455	1.067	0.731	2183	4.256	2.158	217	13.05	688	27.2	1.34	1.033	53.6	896
410	3.302	1.077	0.553	2153	4.278	2.221	200	13.42	688	28.2	1.24	1.054	51.5	952
420	4.370	1.088	0.425	2123	4.302	2.291	185	13.79	688	29.8	1.16	1.075	49.4	1010
430	5.699	1.099	0.331	2091	4.331	2.369	173	14.14	685	30.4	1.09	1.10	47.2	
440	7.333	1.110	0.261	2059	4.36	2.46	162	14.50	682	31.7	1.04	1.12	45.1	
450	9.319	1.123	0.208	2024	4.40	2.56	152	14.85	678	33.1	0.99	1.14	42.9	
460	11.71	1.137	0.167	1989	4.44	2.68	143	15.19	673	34.6	0.95	1.17	40.7	
470	14.55	1.152	0.136	1951	4.48	2.79	136	15.54	667	36.3	0.92	1.20	38.5	
480	17.90	1.167	0.111	1912	4.53	2.94	129	15.88	660	38.1	0.89	1.23	36.2	
490	21.83	1.184	0.0922	1870	4.59	3.10	124	16.23	651	40.1	0.87	1.25	33.9	—
500	26.40	1.203	0.0766	1825	4.66	3.27	118	16.59	642	42.3	0.86	1.28	31.6	—
510	31.66	1.222	0.0631	1779	4.74	3.47	113	16.95	631	44.7	0.85	1.31	29.3	—
520	37.70	1.244	0.0525	1730	4.84	3.70	108	17.33	621	47.5	0.84	1.35	26.9	—
530	44.58	1.268	0.0445	1679	4.95	3.96	104	17.72	608	50.6	0.85	1.39	24.5	—
540	52.38	1.294	0.0375	1622	5.08	4.27	101	18.1	594	54.0	0.86	1.43	22.1	—
550	61.19	1.323	0.0317	1564	5.24	4.64	97	18.6	580	58.3	0.87	1.47	19.7	—
560	71.08	1.355	0.0269	1499	5.43	5.09	94	19.1	563	63.7	0.90	1.52	17.3	—
570	82.16	1.392	0.0228	1429	5.68	5.67	91	19.7	548	76.7	0.94	1.59	15.0	—
580	94.51	1.433	0.0193	1353	6.00	6.40	88	20.4	528	76.7	0.99	1.68	12.8	—
590	108.3	1.482	0.0163	1274	6.41	7.35	84	21.5	513	84.1	1.05	1.84	10.5	—
600	123.5	1.541	0.0137	1176	7.00	8.75	81	22.7	497	92.9	1.14	2.15	8.4	—
610	137.3	1.612	0.0115	1068	7.85	11.1	77	24.1	467	103	1.30	2.60	6.3	—
620	159.1	1.705	0.0094	941	9.35	15.4	72	25.9	444	114	1.52	3.46	4.5	—
625	169.1	1.778	0.0085	858	10.6	18.3	70	27.0	430	121	1.65	4.20	3.5	—
630	179.7	1.856	0.0075	781	12.6	22.1	67	28.0	412	130	2.0	4.8	2.6	—
635	190.9	1.935	0.0066	683	16.4	27.6	64	30.0	392	141	2.7	6.0	1.5	—
640	202.7	2.075	0.0057	560	26	42	59	32.0	367	155	4.2	9.6	0.8	—
645	215.2	2.351	0.0045	361	90	—	54	37.0	331	178	12	26	0.1	—
647.3[c]	221.2	3.170	0.0032	0	∞	∞	45	45.0	238	238	∞	∞	0.0	—

[a]Adapted from Reference 19.
[b]1 bar = 10^5 N/m².
[c]Critical temperature.

L-3/T-2/ME **Date : 18/07/2011**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2009-2010

Sub : **ME 323** (Fluid Mechanics II)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The questions are of equal value.

Assume reasonable data if necessary.

1. (a) Write the advantages and disadvantages of dimensional analysis. Explain Buckingham π-theorem.

   (b) The discharge over a prototype open channel is 200 m^3/s. Calculate the corresponding discharge over a 1: 30 scale ratio model.

2. (a) Discuss the significance of Mach number in the fluid flow. Deduce an equation for the maximum discharge through a converging nozzle.

   (b) An aircraft is flying at a speed of 1200 km/h through air of temperature 26°C and at a pressure of 101.3 kPa absolute. Calculate the rise in temperature at the nose of the aircraft. Take $R = 287\, {}^{J}\!/_{kg}\, K$ and k = 1.4.

3. (a) Find the area-velocity relationship for compressible and incompressible flows. Explain the effects of variation of cross-sectional area on subsonic, sonic and supersonic flows.

   (b) In the down stream of a normal shock wave in air the pressure, temperature and velocity are 252 kPa absolute, 102°C and 182 m/s. respectively. Find the pressure, temperature and density in the upstream of the shock wave. Take k = 1.4 and $R = 287\, {}^{J}\!/_{kg}\, K$

4. (a) Explain boundary layer with diagram. Find the equations of momentum thickness and energy thickness.

   (b) Describe the different types of similarities which may exist between a model and a prototype.

Contd P/2

ME 323

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.
The figures in the margin indicate full marks.
Assume reasonable data if necessary. Moody diagram is supplied.

5. (a) For laminar flow in pipe, prove that the friction factor, $f = \frac{64}{\text{Re}}$, where Re is the Reynolds number. **(18)**

(b) A certain fluid of specific gravity 1.5 and dynamic viscosity 0.8 N-s/m^2 is flowing through a pipe of diameter 110 mm. If the wall shear stress is 210 N/m^2, find the discharge and velocity at a radius of 40 mm from the pipe surface. **(17)**

6. (a) What is minor losses and why is it so called? Derive an equation for the loss of head due to friction in pipes for turbulent flow. **(17)**

(b) Petroleum oil is flowing through an inclined galvanized pipe at the rate of 0.25 m^3/s. At point (1) pressure is 2500 kPa and at point(2) pressure is atmospheric as shown in Fig. for Q. No. 6(b). Neglecting minor losses, find the diameter of the pipe. Specific gravity of petroleum oil is 0.75 and its absolute viscosity is 2.9×10^{-4} N-s/m^2. **(18)**

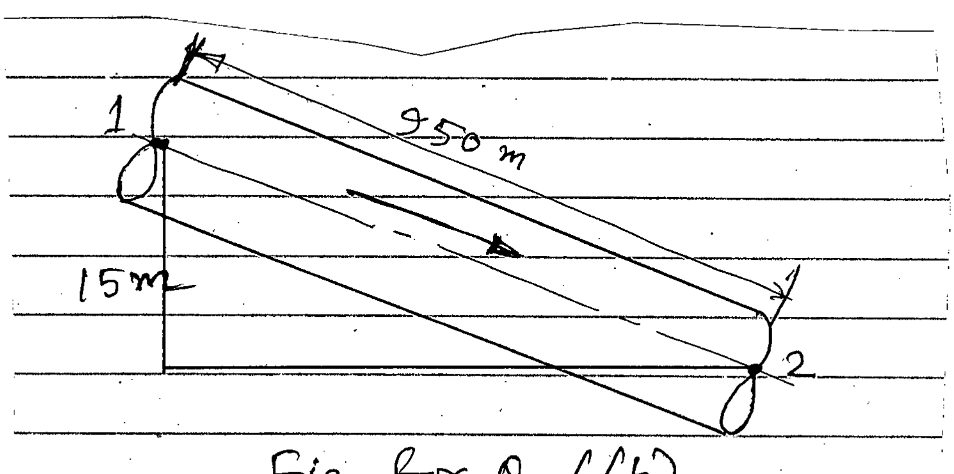

Fig. for Q. 6(b)

7. (a) What is the difference between open channel flow and pipe flow? Prove that for the most economical trapezoidal open channel the angle of sloping side is 60° and the length of the sloping side is equal to the width of the trapezoidal section at the bottom. **(18)**

(b) Water is flowing through a circular open channel having a bed slope of 1 in 8500. the flow rate of water is 0.5 m^3/s and the depth of water in the channel is 0.85 times the diameter. Calculate the diameter of the channel if the Manning's constant n = 0.016. **(17)**

8. (a) State Chezy's formula for open channel flow. Give the derivation of this formula mentioning the assumption. **(15)**

(b) What is specific energy in open channel flow? Explain the physical significance of it. **(10)**

(c) Explain the critical depth in reference to open channel flow. **(10)**

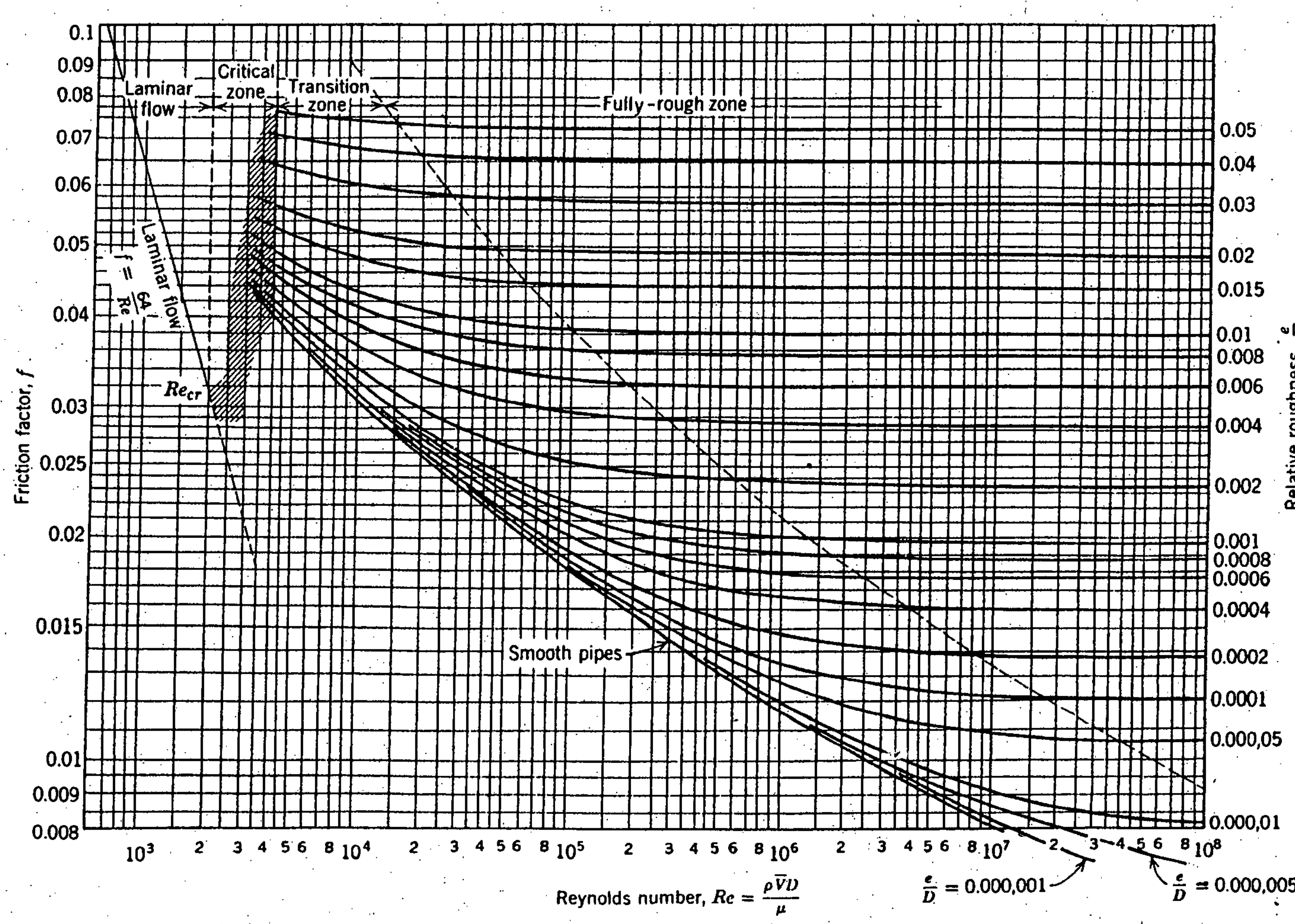

Fig. Moody diagram

	ϵ, mm
Riveted steel	0.9-9.
Concrete	0.3-3.
Wood stave	0.18-0.9
Cast iron	0.25
Galvanized iron	0.15
Asphalted cast iron	0.12
Commercial steel or wrought iron	0.046
Drawn tubing	0.0015

L-3/T-2/ME **Date : 26/06/2011**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2009-2010

Sub : **IPE 331** (Production Process)

Full Marks: 280 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) What are some of the materials used in making casting patterns? What features should be considered when selecting a pattern materials. **(10)**

   (b) With the help of diagram discuss the following **($16\frac{2}{3}$)**

   i) Die casting and

   (ii) Centrifugal casting

   (c) What features can be incorporated into the gating system to aid in trapping dross and mold material that is flowing with the molten metal? **(10)**

   (d) What are some of the general defects encountered in casting process? How might defective castings be repaired to permit successful use in their intended application? **(10)**

2. (a) What is the difference between open die and impression die forging? Why is open-die forging not a practical technique for large scale production of identical products? Explain. **(10)**

   (b) With the help of diagram describe the following cold working of metals. **($16\frac{2}{3}$)**

   i) Roll forging

   ii) Heading and

   iii) Radial forging

   (c) With the help of suitable diagram, discuss the terminology of an impression die forging. **(10)**

   (d) What are some of the attractive features of the extrusion process? What is the primary shape limitation of the extrusion process? **(10)**

3. (a) Explain why and how continuous and discontinuous chips are formed. Discuss why Built-up-Edge (BUE) on a cutting tool is undesirable. **(12)**

   (b) Prove by Master line Method for a single point cutting tool. **($22\frac{2}{3}$)**

   i) $\tan \gamma_y = \tan \gamma_0 \cos \varphi + \tan \lambda \sin \varphi$

   ii) $\cot \alpha_x = \cot \alpha_0 \cos \varphi + \tan \lambda \sin \varphi$

   Where the notation s indicate their usual meaning.

Contd P/2

IPE 331

Contd . . . Q. No. 3

(c) The geometry of a cutting tool used for an operation is given by 0°, 9°, 6°, 6°, 7°, 60°, 1 (mm). Calculate

i) Side rake angle ii) back rake angle and iii) maximum rake angle **(12)**

4. (a) With the help of Earnest and Merchant theory, Show that $P_z = 2\,\gamma_s\,S_0 t\,\text{Cot}\,\beta$ **(15)**

(b) During a metal cutting test under orthogonal conditions in a lathe with tool of rake angle 20° and main cutting edge angle 60°, with a depth of cut of 3 mm and feed rate of 0.38 mm/rev, the following data was recorded. **($12\frac{2}{3}$)**

Average chip thickness = 0.89
Feed force = 835 N
Main cutting force = 1570 N
Calculate the following
i) Coefficient of friction at the chip tool interface
ii) Shear plane angle and
iii) Shear stress at the shear plane

(c) With the help of diagram, define the following terms in cold working of metals.

i) Dimpling ii) Beading and iii) Ironing **(12)**

(d) List some operations that can be classified as bending. Use sketches and explain design functions of the products. **(07)**

SECTION – B

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

5. (a) Briefly describe the application of any three work holding devices used in a lathe machine. **(12)**

(b) In Fig. 5(b) a component to be machined from a stock of C40 steel, 40 mm in diameter and 75 mm long is shown. Calculate the machining time required for completing the part with carbide tool. The available spindle speeds are 70, 110, 176, 280, 440, 700, 1100, 1760 and 2800. Use a cutting speed of 135 m/min, feed rate of 0.38mm/rev and maximum depth of cut is 2 mm. **(13)**

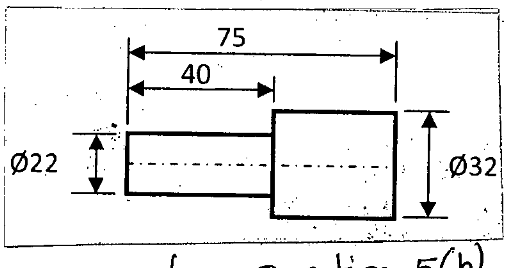

Fig. for Question 5(b)

IPE 331

Contd . . . Q. No. 5

(c) What is centreless grinding? Describe with necessary sketches. **$(9\frac{2}{3})$**

(d) What is meant by grain size, grade and structure of a grinding wheel? **(12)**

6. (a) Differentiate helical and plain milling cutter used in horizontal milling machine. **(12)**

(b) Calculate the indexing requirement for 167 divisions on a milling machine equipped with a differential indexing head. The index plates available are, **(16)**

Plate 1 : 15, 16, 17, 18, 19, 20 holes

Plate 2 : 21, 23, 27, 29, 31, 33 holes

Plate 3 : 37, 39, 41, 43, 47, 49 holes

The change gear set available is 24, 24, 28, 32, 40, 44, 48, 56, 64, 72, 86, 100.

(c) Explain the need for a clapper box in a mechanical shaper. Give the advantages and disadvantages of a hydraulic shaper as compared to a mechanical shaper. **$(9\frac{2}{3}+9)$**

7. (a Write down the sequence of operation required to obtain a hole that is accurate as to size and aligned on center. Briefly describe each operation. **$(15\frac{2}{3})$**

(b) Classify different types of drills used in drill press. **(15)**

(c) Why inadequate joint penetration and slag inclusions are occurred in welds and how these defects can be removed/controlled? **(16)**

8. (a) Write down some advantages, disadvantages and practical applications of welding. **(15)**

(b) With necessary sketches describe briefly the working principle of **(18)**

(i) Resistance spot welding.

(ii) Thermit welding.

(c) Compare shielded metal are welding with the other are welding processes. **$(13\frac{2}{3})$**
