L-3/T-2/ME **Date : 30/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **ME 307** (Heat Transfer Equipment Design)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning and interpretation.

Assume a reasonable value for missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A system for the storage of thermal energy is to be designed using an underground tank of water. The tank is buried at a depth of 3 m and is a cube of 1 m on each side. The water in the tank is heated by circulating it through a solar energy collection system. A given heat input to the water may be assumed due to the solar energy flux. Characterize the design problem in terms of the fixed quantities and design variables. **(10)**

(b) A company is considering adding a new machine to one of its processing lines. The initial cost of the machine is Tk. 300,000. The addition of the machine is expected to increase the company's profit by Tk. 85,000 per year. The service life of the machine is 10 years, and there is no salvage value. The company's corporate tax rate is 35%. Determine the rate of return provided by this machine for the following scenarios, **(25)**

(i) Before taxes with no depreciation

(ii) After taxes with no depreciation

(iii) After taxes using Straight-Line Depreciation (SLD)

(iv) After taxes using Sum of the Year's Digits (SYD)

2. (a) For the design of an electric heat treatment furnace, consider the system shown in Figure for Q. No. 2(a). For the walls and insulation, the thickness is much smaller than the corresponding height and width. The flow rate of gases, which provides an environment of inert gases and nitrogen, is driven by buoyancy and a fan, giving rise to turbulent flow in the enclosed region. The heat source is a thin metal strip with embedded electric heaters. The material being heat treated is a metal block and is small compared to the dimensions of the furnace. This thermal system is initially at room temperature T_r and the material is raised to a desired temperature level, followed by gradual cooling obtained by controlling the energy input to the heaters. Discuss and develop a simple mathematical model for this system. **(15)**

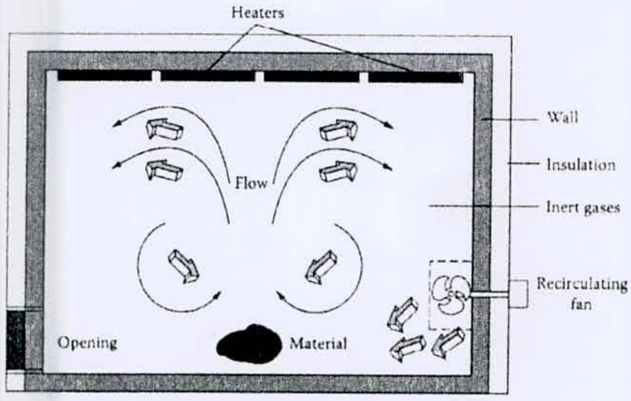

Figure for Q. No. 2 (a)

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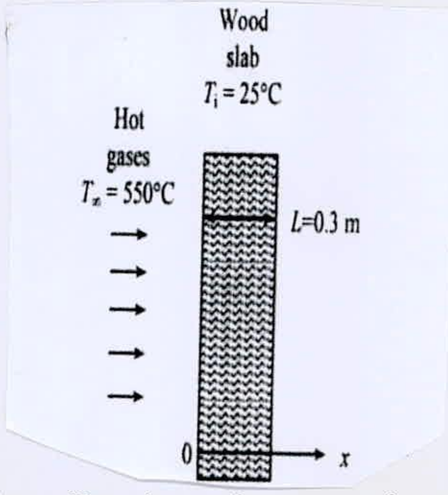
Contd ... Q. No. 2

(b) A thick wood slab (k = 0.17 W/m.K and $\alpha = 1.28 \times 10^{-7}$ m^2/s) that is initially at a uniform temperature of 25°C is exposed to hot gases at 550°C for a period of 5 min. The heat transfer coefficient between the gases and the wood slab is 35 $W/m^2.K$. If the ignition temperature of the wood is 450°C, determine whether the wood will ignite, or not. **(20)**



3. (a) How does rainy weather affect the performance of a cooling tower? What is the approach of a cooling tower and how can it be improved? **(10)**

(b) Consider a chiller plant system (cooling capacity 500 kW) with COP at 4.5 is designed with a cooling tower, the design entering and leaving condenser water temperature of the cooling tower is 37°C and 32°C respectively, the design wet bulb temperature of the outdoor air is 28°C (concurrent dry-bulb 33.5°C), what are: **(25)**

(i) the cooling tower coefficient

(ii) the required condenser water and air mass rate (in kg/s) in the cooling tower

(iii) The required height of the fill if the tower coefficient flows the following empirical equation–

$$\frac{KaV}{\dot{m}_w} = 0.02 + 0.1H\left(\frac{\dot{m}_w}{\dot{m}_a}\right)^{-0.6} \quad \text{at 'water to air' mass ratio = 1.2}$$

4. (a) What is redundancy in engineering design, and how does it help to improve the reliability and safety of complex systems? What are some common examples of redundant components or systems, and how do they contribute to minimizing the risk of failure or accidents? **(8)**

(b) How is the distribution of external radiation to tube bundles evaluated? Discuss the effect of tube spacing. **(7)**

(c) 150,000 lb/h of flue gases having an analysis (vol%) of CO_2 = 12, H_2O = 12, N_2 = 70, and O_2 = 6 flows over a tube bundle having 2 in. OD tubes at 4 in. square pitch. Tubes per row = 18; length = 10 ft. Determine h_c if the fluid temperature is 353°F and the average gas temperature is 700°F. [At film temperature C_p = 0.2695 Btu/lb.°F; μ = 0.0642 lb/ft.hr and k = 0.02344 Btu/ft.hr.°F] **(20)**

Contd P/3

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SECTION – B

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

5. (a) Define heat exchanger. Give some examples of application of heat exchanger in our practical life. Classify heat-exchangers. **(15)**

(b) Ethylene glycol is heated from 25°C to 40°C at a rate of 2.5 kg/s in a horizontal copper tube (k = 386 W/m.K) with an inner diameter of 2.0 cm and an outer diameter of 2.5 cm. A saturated vapor (Tg = 110°C) condenses on the outside-tube surface with the heat transfer coefficient (in $kW/m^2.K$) given by $9.2/(Tg - Tw)^{0.25}$, where Tw is the average outside-tube wall temperature. What tube length must be used? Take the properties of ethylene glycol to be $\rho = 1109\ kg/m^3$, $c_p = 2428$ J/kg.K, k = 0.253 W/m.K, $\mu = 0.01545$ kg/m.s, and Pr = 148.5. **(20)**

6. (a) Water (C_p = 4180 J/kg.°C) enters the 2.5-cm internal diameter tube of a double-pipe counter-flow heat exchanger at 17°C at a rate of 3 kg/s. Water is heated by steam condensing at 120°C (h_{fg} = 2203 kJ/kg) in the shell. If the overall heat transfer coefficient of the heat exchanger is 900 $W/m^2.°C$, determine the length of the tube required in order to heat the water to 80°C using (i) the LMTD method and (ii) the ε-NTU method. **(20)**

(b) A cross-flow heat exchanger consists of 40 thin walled tubes of 1-cm diameter located in a duct of 1 m × 1 m cross-section. There are no fins attached to the tubes. Cold water (C_p = 4180 J/kg.°C) enters the tubes at 18°C with an average velocity of 3 m/s, while hot air (C_p = 1010 J/kg.°C) enters the channel at 130°C and 105 kPa at an average velocity of 12 m/s. If the overall heat transfer coefficient is 130 $W/m^2.°C$, determine the outlet temperatures of both fluids and the rate of heat transfer. **(15)**

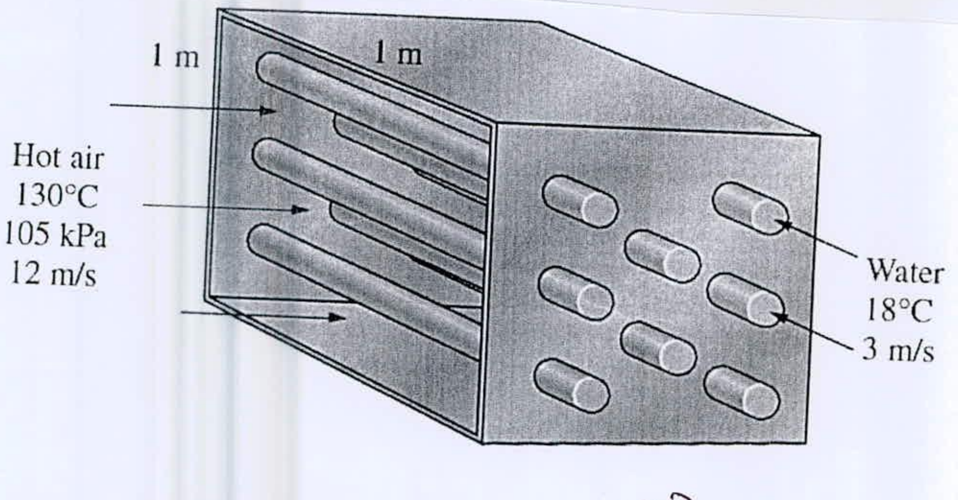

Figure for the Q. No. 2(b) 6(b)

7. A heat exchanger is required to heat treated cooling water with a flow rate of 60 kg/s from 10°C to 50°C using the waste heat from water, cooling from 60°C o 20°C with the same flow rate as the cold water. The maximum allowable pressure drop for both streams is 120 kPa. A gasketed-plate heat exchanger with 301 plates having a channel width of 50 cm, a port diameter of 0.15 m and a vertical distance between ports of 1.5 m is proposed and the plate pitch is 0.0035 m with an enlargement factor of 1.25. The spacing between the plates is 0.6 mm. Plates are made of stainless steel (316) (k = 16.5 W/m.K). Plate thickness 0.6 mm, Chevron angle 45 degrees, Total effective area 320 m^2, Compressed plate pack length 1.08 m, Horizontal port distance 0.40 m. Total fouling resistance is hot fluid side is 0.00005 m^2.K/W. For a two-pass/ two-pass arrangement, analyze the problem to see if the proposed design is feasible in terms of heat transfer and pressure drop. **(35)**

8. (a) Steam in a heating system flows through tubes whose outer diameter is 5 cm and whose walls are maintained at a temperature of 180°C. Circular aluminum alloy 2024-T6 find (k = 186 W/m.°C) of outer diameter 6 cm and constant thickness 1 mm are attached to the tube. The space between the fins is 3 mm, and thus there are 250 fins per meter length of the tube. Heat is transferred to the surrounding air at T_∞ = 25°C, with a heat transfer coefficient of 40 W/m^2.°C. Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins. **(15)**

(b) A homogeneous spherical piece of radioactive material of radius r_0 = 0.05 m that is generating heat at constant rate of $e_{gen} = 7.5 \times 10^7$ W/m^3 as shown in Fig. for Q. 8(b). The heat generated is dissipated to the environment steadily. The outer surface of the sphere is maintained at a uniform temperature of 110°C and the thermal conductivity of the sphere is k = 25 W/m.K. **(20)**

Assuming steady one-dimensional heat transfer,

(i) express the differential equation and the boundary conditions for heat conduction through the sphere,

(ii) Obtain a relation for the variation of temperature in the sphere by solving the differential equation, and

(iii) determine the temperature at the center of the sphere.

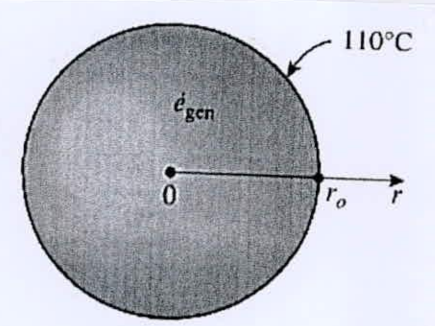

Figure for the Q. No. ~~4(b)~~ 8(b)

Appendix

TABLE 2.2

Interest Factors for Discrete Compounding

Name	Converts	Symbol	Computed by
Single Payment Compound Amount	P to F	$\left(\frac{F}{P},i,n\right)$	$(1+i)^n$
Present Worth	F to P	$\left(\frac{P}{F},i,n\right)$	$(1+i)^{-n}$
Uniform Series Sinking Fund	F to A	$\left(\frac{A}{F},i,n\right)$	$\frac{i}{(1+i)^n-1}$
Compound Amount	A to F	$\left(\frac{F}{A},i,n\right)$	$\frac{(1+i)^n-1}{i}$
Capital Recovery	P to A	$\left(\frac{A}{P},i,n\right)$	$\frac{i(1+i)^n}{(1+i)^n-1}$
Uniform Series Present Worth	A to P	$\left(\frac{P}{A},i,n\right)$	$\frac{(1+i)^n-1}{i(1+i)^n}$
Gradient Present Worth	G to P	$\left(\frac{P}{G},i,n\right)$	$\frac{(1+i)^n-1}{i^2(1+i)^n}-\frac{n}{i(1+i)^n}$

TRANSIENT HEAT CONDUCTION IN SEMI-INFINITE SOLIDS

Case 1: Specified Surface Temperature, T_s = constant (Fig. 4–25).

$$\frac{T(x,t)-T_i}{T_s-T_i}=\operatorname{erfc}\left(\frac{x}{2\sqrt{\alpha t}}\right) \quad \text{and} \quad \dot{q}_s(t)=\frac{k(T_s-T_i)}{\sqrt{\pi \alpha t}}$$

Case 2: Specified Surface Heat Flux, $\dot{q}_s$ = constant.

$$T(x,t)-T_i=\frac{\dot{q}_s}{k}\left[\sqrt{\frac{4\alpha t}{\pi}}\exp\left(-\frac{x^2}{4\alpha t}\right)-x\operatorname{erfc}\left(\frac{x}{2\sqrt{\alpha t}}\right)\right]$$

Case 3: Convection on the Surface, $\dot{q}_s(t)=h[T_\infty - T(0,t)]$.

$$\frac{T(x,t)-T_i}{T_\infty-T_i}=\operatorname{erfc}\left(\frac{x}{2\sqrt{\alpha t}}\right)-\exp\left(\frac{hx}{k}+\frac{h^2\alpha t}{k^2}\right)\operatorname{erfc}\left(\frac{x}{2\sqrt{\alpha t}}+\frac{h\sqrt{\alpha t}}{k}\right) \quad \text{(4–47)}$$

Case 4: Energy Pulse at Surface, e_s = constant.
Energy in the amount of e_s per unit surface area (in J/m²) is supplied to the semi-infinite body instantaneously at time $t = 0$ (by a laser pulse, for example), and all energy is assumed to enter the body, with no heat loss from the surface.

$$T(x,t)-T_i=\frac{e_s}{k\sqrt{\pi t/\alpha}}\exp\left(-\frac{x^2}{4\alpha t}\right) \quad \text{(4–48)}$$

TABLE 4–4

The complementary error function

η	erfc (η)	η	erfc (η)	η	erfc (η)	η	erfc (η)	η	erfc (η)	η	erfc (η)
0.00	1.00000	0.38	0.5910	0.76	0.2825	1.14	0.1069	1.52	0.03159	1.90	0.00721
0.02	0.9774	0.40	0.5716	0.78	0.2700	1.16	0.10090	1.54	0.02941	1.92	0.00662
0.04	0.9549	0.42	0.5525	0.80	0.2579	1.18	0.09516	1.56	0.02737	1.94	0.00608
0.06	0.9324	0.44	0.5338	0.82	0.2462	1.20	0.08969	1.58	0.02545	1.96	0.00557
0.08	0.9099	0.46	0.5153	0.84	0.2349	1.22	0.08447	1.60	0.02365	1.98	0.00511
0.10	0.8875	0.48	0.4973	0.86	0.2239	1.24	0.07950	1.62	0.02196	2.00	0.00468
0.12	0.8652	0.50	0.4795	0.88	0.2133	1.26	0.07476	1.64	0.02038	2.10	0.00298
0.14	0.8431	0.52	0.4621	0.90	0.2031	1.28	0.07027	1.66	0.01890	2.20	0.00186
0.16	0.8210	0.54	0.4451	0.92	0.1932	1.30	0.06599	1.68	0.01751	2.30	0.00114
0.18	0.7991	0.56	0.4284	0.94	0.1837	1.32	0.06194	1.70	0.01612	2.40	0.00069
0.20	0.7773	0.58	0.4121	0.96	0.1746	1.34	0.05809	1.72	0.01500	2.50	0.00041
0.22	0.7557	0.60	0.3961	0.98	0.1658	1.36	0.05444	1.74	0.01387	2.60	0.00024
0.24	0.7343	0.62	0.3806	1.00	0.1573	1.38	0.05098	1.76	0.01281	2.70	0.00013
0.26	0.7131	0.64	0.3654	1.02	0.1492	1.40	0.04772	1.78	0.01183	2.80	7.5E-05
0.28	0.6921	0.66	0.3506	1.04	0.1413	1.42	0.04462	1.80	0.01091	2.90	4.1E-05
0.30	0.6714	0.68	0.3362	1.06	0.1339	1.44	0.04170	1.82	0.01006	3.00	2.2E-05
0.32	0.6509	0.70	0.3222	1.08	0.1267	1.46	0.03895	1.84	0.00926	3.20	6.0E-06
0.34	0.6306	0.72	0.3086	1.10	0.1198	1.48	0.03635	1.86	0.00853	3.40	1.5E-06
0.36	0.6107	0.74	0.2953	1.12	0.1132	1.50	0.03390	1.88	0.00784	3.60	3.6E-07

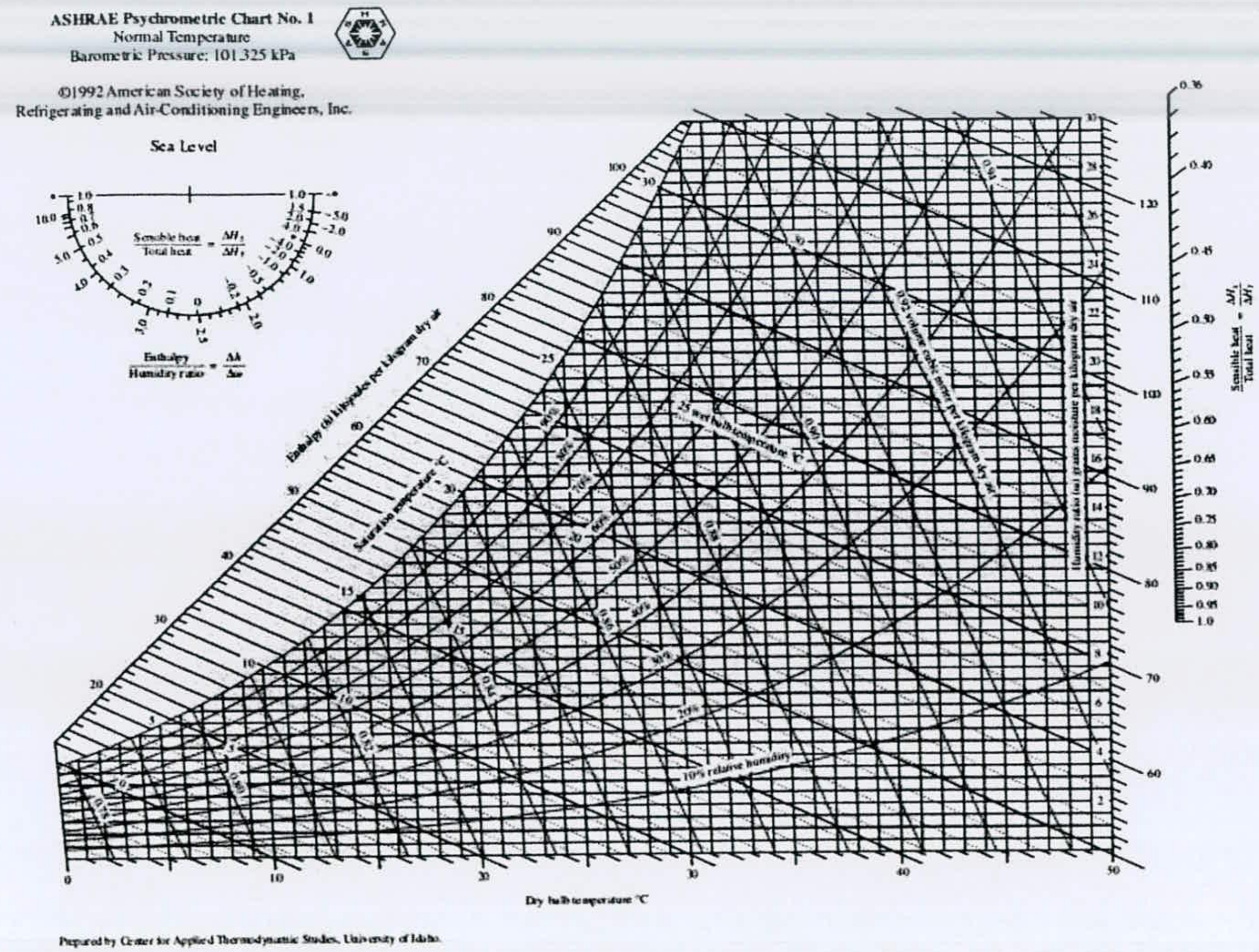

FIGURE A–31

Psychrometric chart at 1 atm total pressure.

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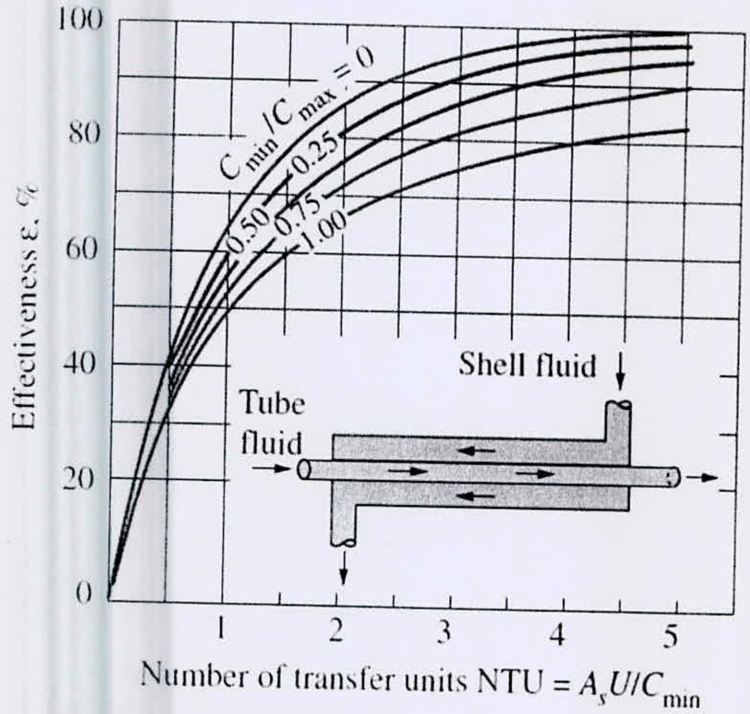
TABLE 8.5 Grimson's Values of B and N

	$S_T/d = 1.25$		$S_T/d = 1.5$		$S_T/d = 2$		$S_T/d = 3$	
S_L/d	B	N	B	N	B	N	B	N
Staggered								
1.25	0.518	0.556	0.505	0.554	0.519	0.556	0.522	0.562
1.50	0.451	0.568	0.460	0.562	0.452	0.568	0.488	0.568
2.0	0.404	0.572	0.416	0.568	0.482	0.556	0.449	0.570
3.0	0.310	0.592	0.356	0.580	0.44	0.562	0.421	0.574
In-line								
1.25	0.348	0.592	0.275	0.608	0.100	0.704	0.0633	0.752
1.50	0.367	0.586	0.250	0.620	0.101	0.702	0.0678	0.744
2.0	0.418	0.570	0.299	0.602	0.229	0.632	0.198	0.648
3.0	0.290	0.601	0.357	0.584	0.374	0.581	0.286	0.608

Double Pipe Heat Exchanger

Laminar: $Nu = 1.86(Gz)^{1/3}\left(\frac{\mu_b}{\mu_w}\right)^{0.14}$; $\quad Gz = \frac{RePr}{L/D}$

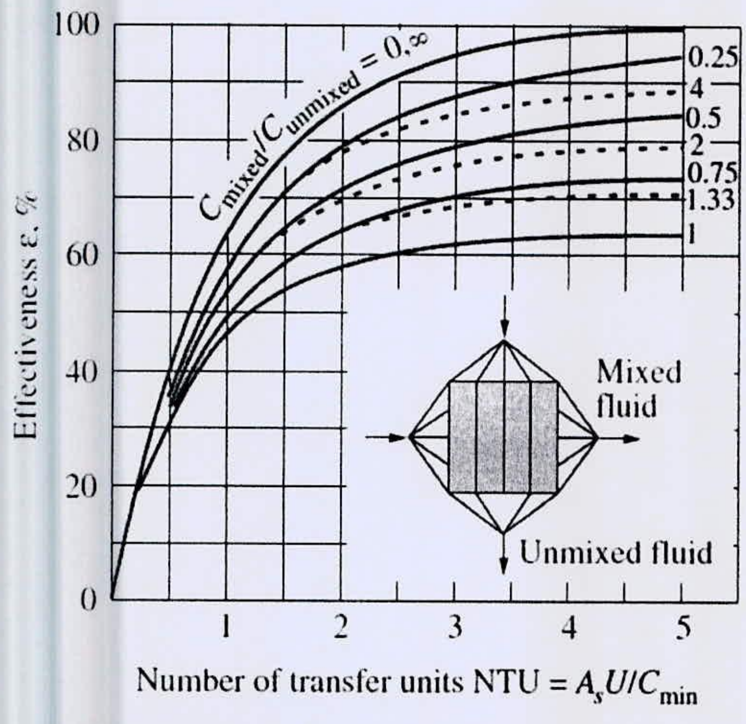
Turbulent: $Nu = 0.023Re^{0.8}Pr^{n}$; $\quad n = \begin{cases} 0.4 & : heating \\ 0.3 & : cooling \end{cases}$



(*b*) Counter-flow

The value of the capacity ratio c ranges between 0 and 1. For a given NTU, the effectiveness becomes a *maximum* for $c = 0$ and a *minimum* for $c = 1$. The case $c = C_{min}/C_{max} \rightarrow 0$ corresponds to $C_{max} \rightarrow \infty$, which is realized during a phase-change process in a *condenser* or *boiler*. All effectiveness relations in this case reduce to

$$\varepsilon = \varepsilon_{max} = 1 - \exp(-NTU)$$



(*f*) Cross-flow with one fluid mixed and the other unmixed

Plate & Frame Heat Exchanger

$$\frac{hD_h}{k} = C_h\left(\frac{D_hG_c}{\mu}\right)^n\left(\frac{c_p\mu}{k}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.17}$$

$$Re = \frac{G_cD_h}{\mu}$$

$$G_c = \frac{\dot{m}}{N_{cp}bL_w}$$

$$N_{cp} = \frac{N_t - 1}{2N_p}$$

$$\Delta p_c = 4f\,\frac{L_{eff}N_p}{D_h}\,\frac{G_c^2}{2\rho}\left(\frac{\mu_b}{\mu_w}\right)^{-0.17}$$

$$f = \frac{K_p}{Re^m}$$

$$\Delta p_p = 1.4N_p\frac{G_p^2}{2\rho}$$

$$G_p = \frac{\dot{m}}{\frac{\pi D_p^2}{4}}$$

$$\Delta p_t = \Delta p_c + \Delta p_p$$

Constants for Single-Phase Heat Transfer and Pressure Loss Calculation in Gasketed-Plate Heat Exchangers[2,10]

Chevron Angle (degree)	Heat Transfer			Pressure Loss		
	Reynolds Number	C_h	n	Reynolds Number	K_p	m
≤30	≤10	0.718	0.349	<10	50.000	1.000
	>10	0.348	0.663	10–100	19.400	0.589
				>100	2.990	0.183
45	<10	0.718	0.349	<15	47.000	1.000
	10–100	0.400	0.598	15–300	18.290	0.652
	>100	0.300	0.663	>300	1.441	0.206
50	<20	0.630	0.333	<20	34.000	1.000
	20–300	0.291	0.591	20–300	11.250	0.631
	>300	0.130	0.732	>300	0.772	0.161
60	<20	0.562	0.326	<40	24.000	1.000
	20–400	0.306	0.529	40–400	3.240	0.457
	>400	0.108	0.703	>400	0.760	0.215
≥65	<20	0.562	0.326	50	24.000	1.000
	20–500	0.331	0.503	50–500	2.800	0.451
	>500	0.087	0.718	>500	0.639	0.213

Properties of air at 1 atm pressure

Temp. T, °C	Density ρ, kg/m^3	Specific Heat c_p, J/kg·K	Thermal Conductivity k, W/m·K	Thermal Diffusivity α, m^2/s	Dynamic Viscosity μ, kg/m·s	Kinematic Viscosity ν, m^2/s	Prandtl Number Pr
−150	2.866	983	0.01171	4.158×10^{-6}	8.636×10^{-6}	3.013×10^{-6}	0.7246
−100	2.038	966	0.01582	8.036×10^{-6}	1.189×10^{-5}	5.837×10^{-6}	0.7263
−50	1.582	999	0.01979	1.252×10^{-5}	1.474×10^{-5}	9.319×10^{-6}	0.7440
−40	1.514	1002	0.02057	1.356×10^{-5}	1.527×10^{-5}	1.008×10^{-5}	0.7436
−30	1.451	1004	0.02134	1.465×10^{-5}	1.579×10^{-5}	1.087×10^{-5}	0.7425
−20	1.394	1005	0.02211	1.578×10^{-5}	1.630×10^{-5}	1.169×10^{-5}	0.7408
−10	1.341	1006	0.02288	1.696×10^{-5}	1.680×10^{-5}	1.252×10^{-5}	0.7387
0	1.292	1006	0.02364	1.818×10^{-5}	1.729×10^{-5}	1.338×10^{-5}	0.7362
5	1.269	1006	0.02401	1.880×10^{-5}	1.754×10^{-5}	1.382×10^{-5}	0.7350
10	1.246	1006	0.02439	1.944×10^{-5}	1.778×10^{-5}	1.426×10^{-5}	0.7336
15	1.225	1007	0.02476	2.009×10^{-5}	1.802×10^{-5}	1.470×10^{-5}	0.7323
20	1.204	1007	0.02514	2.074×10^{-5}	1.825×10^{-5}	1.516×10^{-5}	0.7309
25	1.184	1007	0.02551	2.141×10^{-5}	1.849×10^{-5}	1.562×10^{-5}	0.7296
30	1.164	1007	0.02588	2.208×10^{-5}	1.872×10^{-5}	1.608×10^{-5}	0.7282
35	1.145	1007	0.02625	2.277×10^{-5}	1.895×10^{-5}	1.655×10^{-5}	0.7268
40	1.127	1007	0.02662	2.346×10^{-5}	1.918×10^{-5}	1.702×10^{-5}	0.7255
45	1.109	1007	0.02699	2.416×10^{-5}	1.941×10^{-5}	1.750×10^{-5}	0.7241
50	1.092	1007	0.02735	2.487×10^{-5}	1.963×10^{-5}	1.798×10^{-5}	0.7228
60	1.059	1007	0.02808	2.632×10^{-5}	2.008×10^{-5}	1.896×10^{-5}	0.7202
70	1.028	1007	0.02881	2.780×10^{-5}	2.052×10^{-5}	1.995×10^{-5}	0.7177
80	0.9994	1008	0.02953	2.931×10^{-5}	2.096×10^{-5}	2.097×10^{-5}	0.7154
90	0.9718	1008	0.03024	3.086×10^{-5}	2.139×10^{-5}	2.201×10^{-5}	0.7132
100	0.9458	1009	0.03095	3.243×10^{-5}	2.181×10^{-5}	2.306×10^{-5}	0.7111
120	0.8977	1011	0.03235	3.565×10^{-5}	2.264×10^{-5}	2.522×10^{-5}	0.7073
140	0.8542	1013	0.03374	3.898×10^{-5}	2.345×10^{-5}	2.745×10^{-5}	0.7041
160	0.8148	1016	0.03511	4.241×10^{-5}	2.420×10^{-5}	2.975×10^{-5}	0.7014
180	0.7788	1019	0.03646	4.593×10^{-5}	2.504×10^{-5}	3.212×10^{-5}	0.6992
200	0.7459	1023	0.03779	4.954×10^{-5}	2.577×10^{-5}	3.455×10^{-5}	0.6974
250	0.6746	1033	0.04104	5.890×10^{-5}	2.760×10^{-5}	4.091×10^{-5}	0.6946
300	0.6158	1044	0.04418	6.871×10^{-5}	2.934×10^{-5}	4.765×10^{-5}	0.6935
350	0.5664	1056	0.04721	7.892×10^{-5}	3.101×10^{-5}	5.475×10^{-5}	0.6937
400	0.5243	1069	0.05015	8.951×10^{-5}	3.261×10^{-5}	6.219×10^{-5}	0.6948
450	0.4880	1081	0.05298	1.004×10^{-4}	3.415×10^{-5}	6.997×10^{-5}	0.6965
500	0.4565	1093	0.05572	1.117×10^{-4}	3.563×10^{-5}	7.806×10^{-5}	0.6986
600	0.4042	1115	0.06093	1.352×10^{-4}	3.846×10^{-5}	9.515×10^{-5}	0.7037
700	0.3627	1135	0.06581	1.598×10^{-4}	4.111×10^{-5}	1.133×10^{-4}	0.7092
800	0.3289	1153	0.07037	1.855×10^{-4}	4.362×10^{-5}	1.326×10^{-4}	0.7149
900	0.3008	1169	0.07465	2.122×10^{-4}	4.600×10^{-5}	1.529×10^{-4}	0.7206
1000	0.2772	1184	0.07868	2.398×10^{-4}	4.826×10^{-5}	1.741×10^{-4}	0.7260
1500	0.1990	1234	0.09599	3.908×10^{-4}	5.817×10^{-5}	2.922×10^{-4}	0.7478
2000	0.1553	1264	0.11113	5.664×10^{-4}	6.630×10^{-5}	4.270×10^{-4}	0.7539

Properties of saturated water

Temp. T, °C	Saturation Pressure P_{sat}, kPa	Density ρ, kg/m³		Enthalpy of Vaporization h_{fg}, kJ/kg	Specific Heat c_p, J/kg·K		Thermal Conductivity k, W/m·K		Dynamic Viscosity μ, kg/m·s		Prandtl Number Pr		Volume Expansion Coefficient β, 1/K
		Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid
0.01	0.6113	999.8	0.0048	2501	4217	1854	0.561	0.0171	1.792×10^{-3}	0.922×10^{-5}	13.5	1.00	-0.068×10^{-3}
5	0.8721	999.9	0.0068	2490	4205	1857	0.571	0.0173	1.519×10^{-3}	0.934×10^{-5}	11.2	1.00	0.015×10^{-3}
10	1.2276	999.7	0.0094	2478	4194	1862	0.580	0.0176	1.307×10^{-3}	0.946×10^{-5}	9.45	1.00	0.733×10^{-3}
15	1.7051	999.1	0.0128	2466	4185	1863	0.589	0.0179	1.138×10^{-3}	0.959×10^{-5}	8.09	1.00	0.138×10^{-3}
20	2.339	998.0	0.0173	2454	4182	1867	0.598	0.0182	1.002×10^{-3}	0.973×10^{-5}	7.01	1.00	0.195×10^{-3}
25	3.169	997.0	0.0231	2442	4180	1870	0.607	0.0186	0.891×10^{-3}	0.987×10^{-5}	6.14	1.00	0.247×10^{-3}
30	4.246	996.0	0.0304	2431	4178	1875	0.615	0.0189	0.798×10^{-3}	1.001×10^{-5}	5.42	1.00	0.294×10^{-3}
35	5.628	994.0	0.0397	2419	4178	1880	0.623	0.0192	0.720×10^{-3}	1.016×10^{-5}	4.83	1.00	0.337×10^{-3}
40	7.384	992.1	0.0512	2407	4179	1885	0.631	0.0196	0.653×10^{-3}	1.031×10^{-5}	4.32	1.00	0.377×10^{-3}
45	9.593	990.1	0.0655	2395	4180	1892	0.637	0.0200	0.596×10^{-3}	1.046×10^{-5}	3.91	1.00	0.415×10^{-3}
50	12.35	988.1	0.0831	2383	4181	1900	0.644	0.0204	0.547×10^{-3}	1.062×10^{-5}	3.55	1.00	0.451×10^{-3}
55	15.76	985.2	0.1045	2371	4183	1908	0.649	0.0208	0.504×10^{-3}	1.077×10^{-5}	3.25	1.00	0.484×10^{-3}
60	19.94	983.3	0.1304	2359	4185	1916	0.654	0.0212	0.467×10^{-3}	1.093×10^{-5}	2.99	1.00	0.517×10^{-3}
65	25.03	980.4	0.1614	2346	4187	1926	0.659	0.0216	0.433×10^{-3}	1.110×10^{-5}	2.75	1.00	0.548×10^{-3}
70	31.19	977.5	0.1983	2334	4190	1936	0.663	0.0221	0.404×10^{-3}	1.126×10^{-5}	2.55	1.00	0.578×10^{-3}
75	38.58	974.7	0.2421	2321	4193	1948	0.667	0.0225	0.378×10^{-3}	1.142×10^{-5}	2.38	1.00	0.607×10^{-3}
80	47.39	971.8	0.2935	2309	4197	1962	0.670	0.0230	0.355×10^{-3}	1.159×10^{-5}	2.22	1.00	0.653×10^{-3}
85	57.83	968.1	0.3536	2296	4201	1977	0.673	0.0235	0.333×10^{-3}	1.176×10^{-5}	2.08	1.00	0.670×10^{-3}
90	70.14	965.3	0.4235	2283	4206	1993	0.675	0.0240	0.315×10^{-3}	1.193×10^{-5}	1.96	1.00	0.702×10^{-3}
95	84.55	961.5	0.5045	2270	4212	2010	0.677	0.0246	0.297×10^{-3}	1.210×10^{-5}	1.85	1.00	0.716×10^{-3}
100	101.33	957.9	0.5978	2257	4217	2029	0.679	0.0251	0.282×10^{-3}	1.227×10^{-5}	1.75	1.00	0.750×10^{-3}
110	143.27	950.6	0.8263	2230	4229	2071	0.682	0.0262	0.255×10^{-3}	1.261×10^{-5}	1.58	1.00	0.798×10^{-3}
120	198.53	943.4	1.121	2203	4244	2120	0.683	0.0275	0.232×10^{-3}	1.296×10^{-5}	1.44	1.00	0.858×10^{-3}
130	270.1	934.6	1.496	2174	4263	2177	0.684	0.0288	0.213×10^{-3}	1.330×10^{-5}	1.33	1.01	0.913×10^{-3}
140	361.3	921.7	1.965	2145	4286	2244	0.683	0.0301	0.197×10^{-3}	1.365×10^{-5}	1.24	1.02	0.970×10^{-3}
150	475.8	916.6	2.546	2114	4311	2314	0.682	0.0316	0.183×10^{-3}	1.399×10^{-5}	1.16	1.02	1.025×10^{-3}
160	617.8	907.4	3.256	2083	4340	2420	0.680	0.0331	0.170×10^{-3}	1.434×10^{-5}	1.09	1.05	1.145×10^{-3}
170	791.7	897.7	4.119	2050	4370	2490	0.677	0.0347	0.160×10^{-3}	1.468×10^{-5}	1.03	1.05	1.178×10^{-3}
180	1,002.1	887.3	5.153	2015	4410	2590	0.673	0.0364	0.150×10^{-3}	1.502×10^{-5}	0.983	1.07	1.210×10^{-3}
190	1,254.4	876.4	6.388	1979	4460	2710	0.669	0.0382	0.142×10^{-3}	1.537×10^{-5}	0.947	1.09	1.280×10^{-3}
200	1,553.8	864.3	7.852	1941	4500	2840	0.663	0.0401	0.134×10^{-3}	1.571×10^{-5}	0.910	1.11	1.350×10^{-3}
220	2,318	840.3	11.60	1859	4610	3110	0.650	0.0442	0.122×10^{-3}	1.641×10^{-5}	0.865	1.15	1.520×10^{-3}
240	3,344	813.7	16.73	1767	4760	3520	0.632	0.0487	0.111×10^{-3}	1.712×10^{-5}	0.836	1.24	1.720×10^{-3}
260	4,688	783.7	23.69	1663	4970	4070	0.609	0.0540	0.102×10^{-3}	1.788×10^{-5}	0.832	1.35	2.000×10^{-3}
280	6,412	750.8	33.15	1544	5280	4835	0.581	0.0605	0.094×10^{-3}	1.870×10^{-5}	0.854	1.49	2.380×10^{-3}
300	8,581	713.8	46.15	1405	5750	5980	0.548	0.0695	0.086×10^{-3}	1.965×10^{-5}	0.902	1.69	2.950×10^{-3}
320	11,274	667.1	64.57	1239	6540	7900	0.509	0.0836	0.078×10^{-3}	2.084×10^{-5}	1.00	1.97	
340	14,586	610.5	92.62	1028	8240	11,870	0.469	0.110	0.070×10^{-3}	2.255×10^{-5}	1.23	2.43	
360	18,651	528.3	144.0	720	14,690	25,800	0.427	0.178	0.060×10^{-3}	2.571×10^{-5}	2.06	3.73	
374.14	22,090	317.0	317.0	0	—	—	—	—	0.043×10^{-3}	4.313×10^{-5}			

L-3/T-2/ME **Date: 05/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

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

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) What do you mean by stagnation condition in context to fluid flow? Show that the Mach number, M in an isentropic compressible flow can be determined based on stagnation pressure, p_0 and static pressure, p at that location by the following relation: **(10)**

$$M = \sqrt{\frac{2}{k-1}\left[\left(\frac{p_0}{p}\right)^{\frac{k-1}{k}} - 1\right]}$$

where k is the ratio of specific heats.

(b) Air is exhausted supersonically ($M > 1$) from a planar propulsion system as shown in Fig. for Q. 1(b). The depth of the system is 100 mm. Determine the Mach number and pressure at different sections as shown in figure. Height, h at different section is given. Consider 1D isentropic flow in your calculation. **(15)**

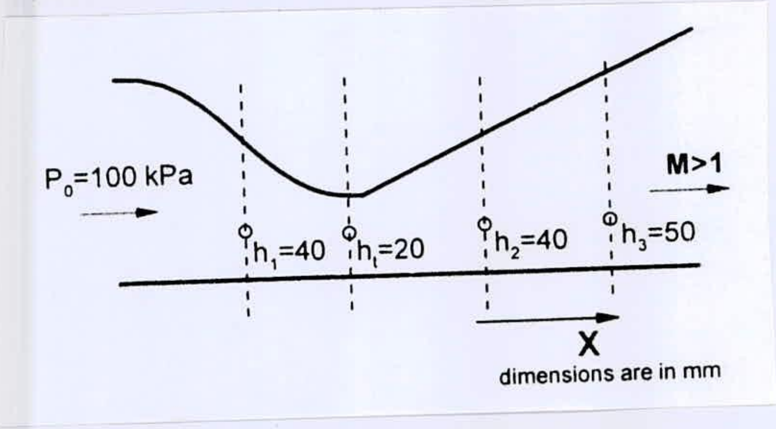


Fig. for Q. 1(b).

(c) Explain the choking phenomena in context to compressible flow through a converging nozzle. Accordingly, determine the maximum possible mass flow rate of air which can be discharged from the converging nozzle. **(10)**

Contd …… P/2

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2. (a) A large tank of volume, V contains a compressed air whose pressure was initially (t = 0) at $p_{0.0}$. The tank is to be depressurized using a converging nozzle with exit area of A_e. Assume that the back pressure, p_b is remained constant and $p_{0.0} >> p_b$. In this process, the pressure inside the tank will decrease with time, t. Model this unsteady process and show that the critical time (until the nozzle is choked) can be determined from the following equation: **(10)**

$$t^* \approx 1.745 \frac{V}{a_0 A_e} \ln\left(\frac{NPR_0}{1.893}\right)$$

where a_0 is the frozen speed of sound and NPR_0 is the initial nozzle pressure ratio ($p_{0.0}/p_b$).

For simplicity of the model, neglect the change of thermal condition inside the tank during the process.

(b) Sea-level standard air is sucked into a vacuum tank through a nozzle, as shown in Fig. for Q. 2(b). A normal shock stands where the nozzle area is 2 cm^2, as shown. Estimate (i) the pressure in the tank, (ii) exit Mach number, and (iii) mass flow rate. **(15)**

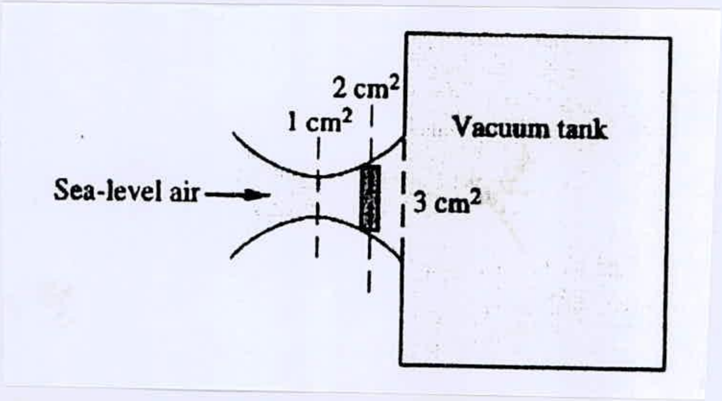

Fig. for Q. 2(b).

(c) Draw the typical distribution of pressure and Mach number along the length of a converging-diverging nozzle in cases of **(10)**

(i) overexpansion

(ii) underexpansion.

3. (a) The wave front emitted by a point source (for example projectile, rocket, etc.) when travelling with speed V_s in a still is shown in Fig. for Q. 3(a). The source locations, S for different equal time intervals (Δt) are also identified in the figure. **(15)**

(i) Construct the propagation of wave fronts at all the source locations.

(ii) Does the source influence the entire flow field? If not, identify the different zones in the flow field.

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Contd... Q. No. 3(a)

(iii) Reconstruct the wave front in case of point source moving at positive (+ve) angle with x-axis.

Note that a is the magnitude of acoustic speed at local condition.

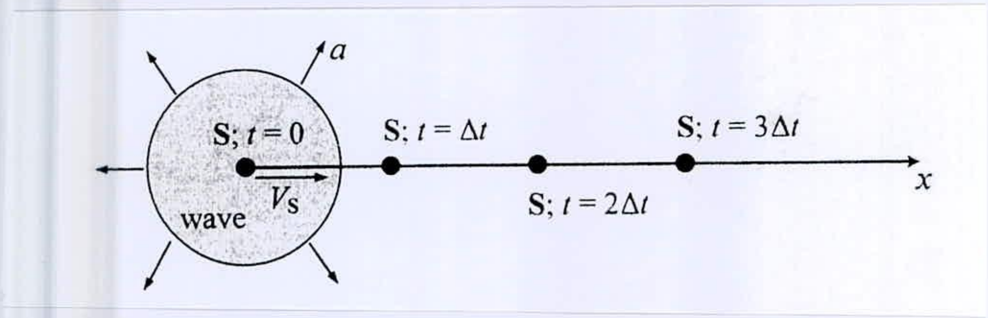

Fig. for Q. 3(a).

(b) Find the diameter of a circular pipe which is laid at a slope of 1 in 8000 and carries a discharge of 800 l/s of water when flowing half-full. Take the value of Manning's constant, N= 0.02. **(20)**

4. (a) Explain the term most economical section of a trapezoidal open channel. Deduce the conditions for the most economical trapezoidal open channel. **(15)**

(b) Find the discharge of water through a rectangular open channel of 6 m wide and 3 m deep, when it is running full. The channel bed slope is 1 in 2000. Take Chezy's constant, C = 55. **(20)**

SECTION – B

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

Assume reasonable value for missing data. Moody diagram is attached.

Symbols have their usual meaning.

5. (a) From the fundamental concept of fluid flow in pipe, derive the expressions for velocity and hence the location of maximum velocity for laminar flow through annular space. Does the maximum velocity occur in the middle of annular space? Explain the reason for your answer. **(17)**

(b) What is minor loss and why is it so called? Find the flow rate through the pipe as shown in Fig. for Q. No. 5(b). Sketch the EGL and HGL. Take υ of water at 20°C as 10^{-6} m^2/s. The loss coefficient are: Screwed globe valve = 6, squared edge entrance = 0.5, standard screwed elbow = 0.95. **(18)**

Contd P/4

6. (a) Define and explain the equivalent pipe length for different pipe fittings. Derive an expression for head loss due to sudden expanssion of pipe. **(17)**

(b) For the water supply system as shown in Fig. for Q. No. 6(b), determine the flow distribution and the piezometric head at the junction. Assume constant friction factors. The pump characteristics curve is $H_p = 20 - 30Q^2$ m. Given that the elevations are Z_1 = 8 m, Z_2 = 22 m and Z_3 = 20 m. Other data are given in Table for Q. No. 6(b). **(18)**

7. (a) Define and explain the similarity laws as used in model study. **(7)**

(b) Write the physical interpretation of Reynolds number, Froude number, Euler number, weber number and derive their mathematical expressions. **(10)**

(c) The power P to drive an axial flow pump depends on the following variables: density of the fluid ρ, speed of rotor N, diameter of rotor D, head H, and volumetric flow rate Q. A model scaled to one third of the size of the prototype has the following characteristics: N_m = 900 rpm, D_m = 12 cm, H_m = 3.5 m, Q_m = 90 l/s, P_m = 1.6 KW. If the full size pump is to run at 300 rpm, what is the power required to run this pump? What head will the pump maintain? What will the volumetric flow rate be? Find the dimensionless groups to be used for solution. **(18)**

8. (a) Discuss boundary layer thickness with diagram. Find the equation of displacement thickness and momentum thickness. **(15)**

(b) Find the displacement thickness, momentum thickness and energy thickness for the velocity distribution in the boundary layer on a plate given by **(20)**

$$\frac{u}{U_0} = \frac{y}{\delta}$$

where u is the velocity at a distance y from the plate, $u = U_0$ at $y = \delta$ and δ is the boundary layer Thickness.

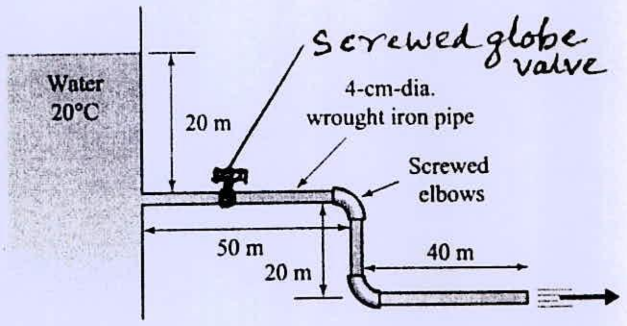

Fig. for Q. No. 5(b)

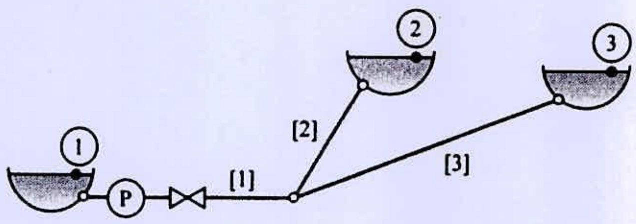

Fig. for Q. No. 6 (b)

Pipe	*L* (m)	*D* (cm)	*f*	*K*
1	30	24	0.020	2
2	60	20	0.015	0
3	90	16	0.025	0

Table for Q. No. 6(b)

=6=

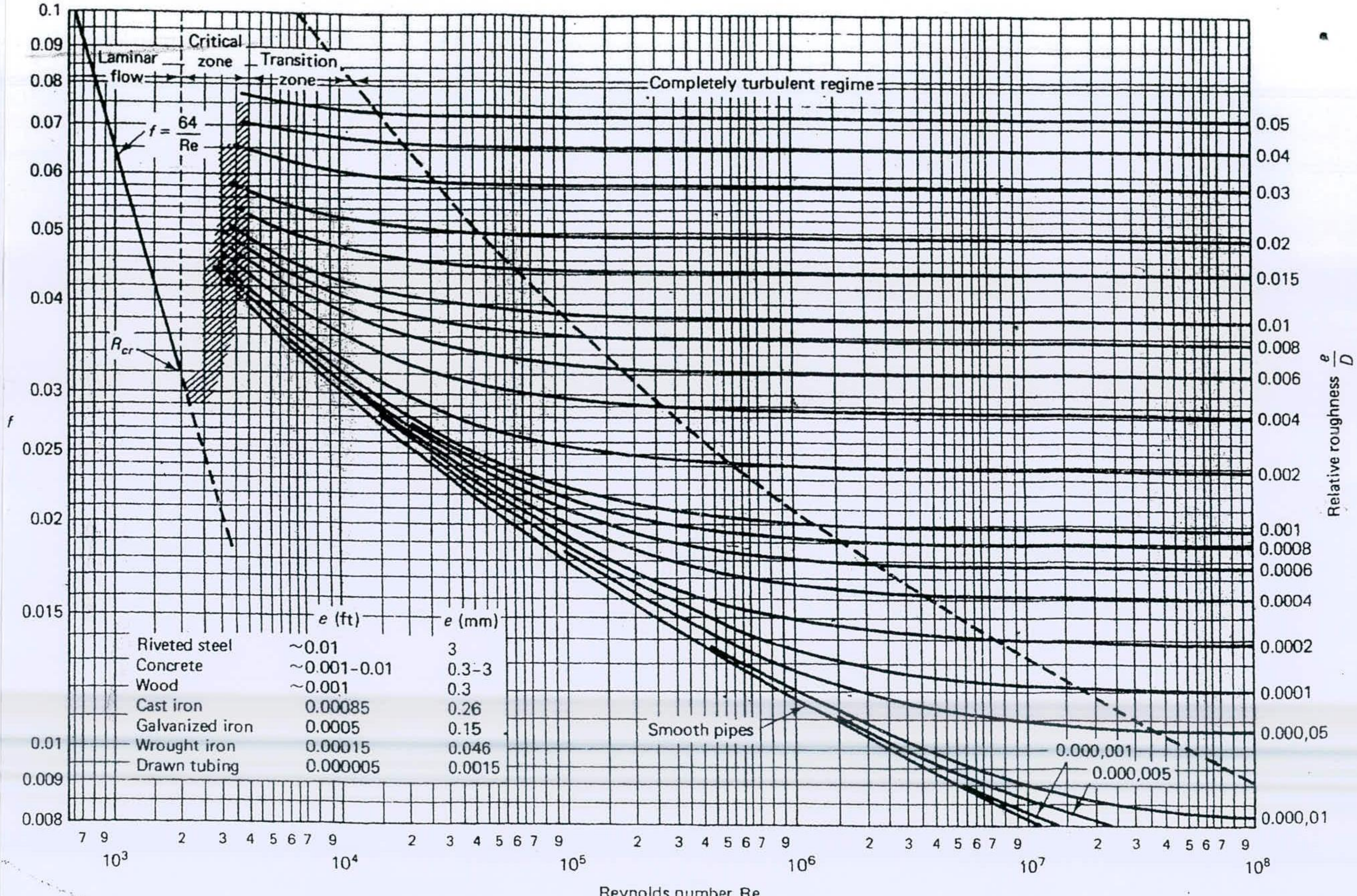

Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)

L-3/T-2/ME **Date: 29/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **ME 351** (Machine Design)

Full Marks: 280 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

Symbols have their usual meanings and interpretation. The Text Book "Shigley's Mechanical Engineering Design" will be supplied. Assume reasonable value for any missing data.

The figures in the margin indicate full marks

SECTION – A

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

1. A motor (with rated power of P hp) running at a speed of 2900 rpm directly transmits power to a triple threaded worm (C.I). The worm drives a chilled cast, 60 teeth bronze gear. The worm gear set is immersed in lubricating oil in the casting. Given, $\phi_n = 30°$, n_D = design factor = 1.2, K_a = load application factor = 1.5, P_t = 4 teeth/inch, d_w = 3 inch, F_e = effective face width = 3 inch. Separating force on gear is designed to be 290.65 lb_f.

   Based on the fact that power is transmitted in the following way: Power source – Worm – Gear

   Find: (i) Resultant force on gear, (ii) rated power of the motor, (iii) safety factor by Buckingham wear equation and (iv) temperature rise of the gear casing. Use AGMA equation for finding friction coefficient f. Assume the worm shaft carries a fan and A = 1.25 A_{min} **$(46\frac{2}{3})$**

2. (a) Given an outboard mounted pair of bevel gears has following data: $\varphi_n = 20°$, same size (N = 25), same material (Cast iron; ASTM A48 Class 40), at 500 rpm driver gear transmits 20kW to the driven one, both gears receive heavy shock, b = 55mm, m_{et} = outer transverse module = 10 mm (at large end), $Q_v = 10$, $n_L = 10^5$ cycles, R = 95%, crowned teeth. Find the safety factor using suitable AGMA equation. **$(22\frac{2}{3})$**

   (b) A fit specified as 400 mm H7/n6 **(24)**

   (i) Calculate all pertinent dimensions of this fit and, by FREE HAND sketch and label the fit.

   (ii) Suppose a workman has to make the fits of the last problem. If 10% of the pins were rejected being less than specifications, and 10% of the pins were rejected being more than specifications, what was the smallest and largest pin dia that were made? Assuming normal probability distribution.

Contd …… P/2

3. (a) A squared & ground helical compression spring is to meet following design requirements: spring index = 12, mean coil dia = 48 mm, active turn number = 10, material is 302 SS (shot peened), loads: F_m = 400N, F_a = 200 N, $\gamma = 82\times10^{-6}$ N/mm^3. Find: (i) safety factor against yielding (i) free length for which buckling is imminent (iii) fundamental natural frequency (iv) full corrected value of shear endurance limit by Sine's theory. Use Zimmerli's data. **($22\frac{2}{3}$)**

(b) A leaf spring (S_{ut} = 700 MPa) has 15 leaves each of width b = 20 mm and thickness h = 10 mm. The main leaf has a span of L = 21 = 600 mm. The spring supports a total vertical load of 2P = 12 kN so that half of this load (P) acts on each tip (eye). Leaves are hot rolled. **(24)**

(i) Assume the total vertical load varies from 0 to 2P. Take temperature factor to be unity. For 50% reliability, find the fatigue safety factor by modified Good Man criterion. Take K_f = 1.6 at center of leaf spring. Assume that because of shot peening fatigue strength increases by 13%.

(ii) Find also the overall/total stiffness of the spring.

4. (a) A centrally loaded, fixed-pinned steel column has to fulfill following design data: Cross-section is channel section (203 × 76 mm), material: steel (yield strength 450 MPa Young's modulus 210 GPa), unsupported length = L mm. **($22\frac{2}{3}$)**

Find (i) L so that either Euler or Johnson's parabolic formula can be used to find the critical & design loads. *Use theoretical value of C.*

(ii) If the load is eccentric, how the buckling load of this column can be evaluated? Explain with neat sketches.

(b) An Al cylinder is connected to its head of same thickness (l = 2t) by 8 identical steel bolts (M24, coarse pitch, property class 8.8). Assume, L = X mm, for a grip l = Y mm, c = 0.35, k_b = 220 kN/m. Given the separating force is 100 kN per bolt. **(24)**

Calculate (i) member stiffness (ii) the pretension per bolt (iii) the maximum and the minimum clamping force with corresponding values of forces in the bolt (iv) chance of bolt failure at separation (v) required torque constant K for each bolt. Given, initial torque after snug fit condition is 125 Nm.

SECTION – B

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

5. (a) Train wheel is running on the rail track where the rail has welded joints at regular distances. The relevant components have the following material properties: **(23)**

Contd P/3

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Contd... Q. No. 5(a)

Component	Young's Modulus (MPa)	Poisson's Ratio
Wheel	210	0.3
Parent rail	210	0.3
Rail welded joint	200	0.24

The wheel has a diameter of 920 mm and the contact width of the wheel is 40 mm. Determine the maximum shear stress developed in each component in terms of the applied contact force *F*. What will be the allowable force if the largest shear stress is limited to 150 MPa?

(b) To support the signpost as shown in Fig. for Q. 5(b), steel shaft AB is used which has an outer diameter of 400 mm. The shaft material is AISI 1040 Q&T with yield strength of 593 MPa. The weight of the signpost is 50 Kgf and a maximum horizontal wind force of P = 2 kN (perpendicular to the signpost plane) can be assumed constantly acting to perform the analysis. Determine the minimum thickness required for shaft AB to carry the loads according to the distribution energy theory with a safety factor of 2. **($23\frac{2}{3}$)**

6. (a) Consider the case where the hull of a ship is subjected to longitudinal stresses. At a section, the rectangular hull plate has the following dimensions: L = 500 mm, W = 300 mm, t = 20 mm. The plate is made of 4340 steel with fracture toughness K_{IC} = 60 MPa$\sqrt{m}$. For the plate subjected to tension as shown in Fig. for Q. 6(a), (i) determine the allowable tensile stress (σ) if an edge crack of length 50 mm is present in the direction perpendicular to the length of the plate (ii) determine the fatigue life in number of cycle if a fluctuating stress between 0 and 0.5 σ is applied. **(30)**

(b) A steel bar of 5 mm thickness to be used as a beam is welded to a vertical support by fillet welds as shown in Fig. for Q. 6(b). If *F* = 1 kN, determine the maximum shear stress developed in the weld. **($16\frac{2}{3}$)**

7. A lever arm is loaded as shown in Fig. for Q. 7. The shaft attached to the arm has a through hole. The force *F* varies between 0 to 10 N. The material is AISI 1040 annealed steel. Consider, machined surface, room temperature operation, 95% reliability. Determine the required diameter *d* of the shaft based on Soderberg formula with a factor of safety of 2. **($46\frac{2}{3}$)**

Contd P/4

ME 351

8. (a) A pressure-fed bearing has a journal diameter of 50 mm with a unilateral clearance of -0.05 mm. The bushing bore diameter is 50.084 mm with a unilateral tolerance of 0.10 mm. The length of the bushing is 55 mm. The lubricating oil is SAE 30 supplied at 55 °C and 200 kPa gauge pressure. The journal rotates at 1800 rpm and the load is 15 kN. For minimum radial clearance, (i) Find the average film temperature (ii) maximum bearing pressure and (iii) volumetric side flow. **(20)**

(b) A 10 kW electric motor running at 1500 rpm is used to drive the raw materials mixer machine (runs at 300 rpm) in a ceramic industry. The sheaves should be spaced approximately 1.5 m apart. Steel a V-belt drive for this application. **($26\frac{2}{3}$)**

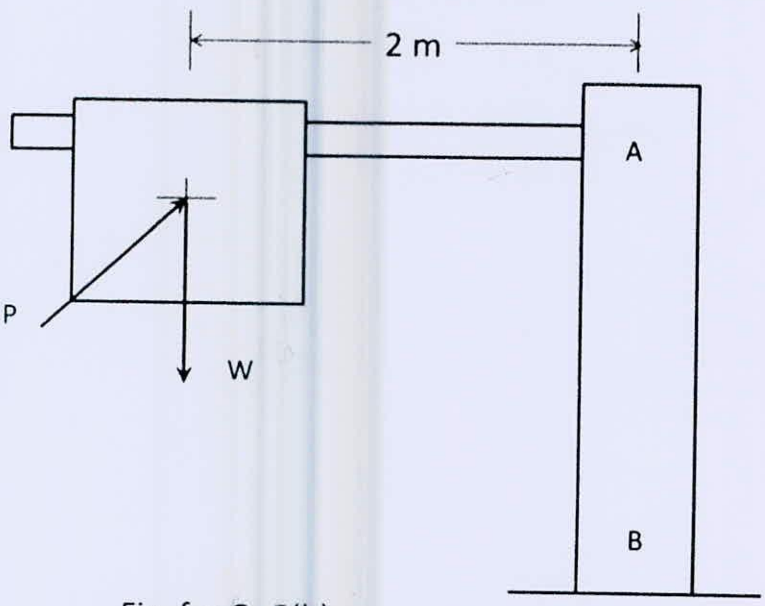

Fig. for Q. 5(b)

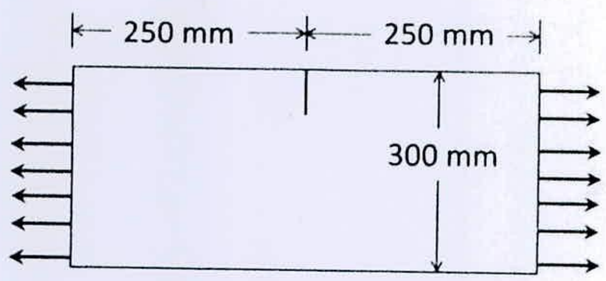

Fig. for Q. 6(a)

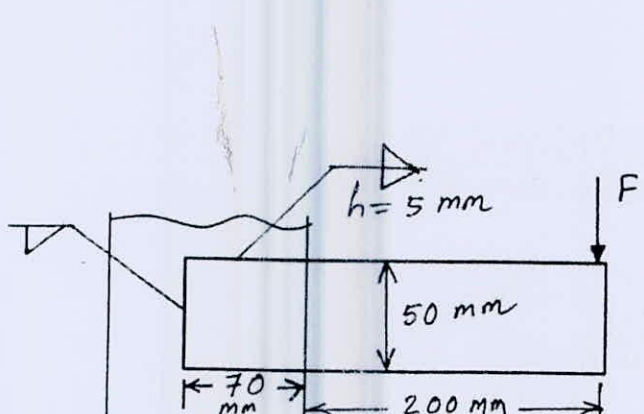

Fig. for Q. 6(b)

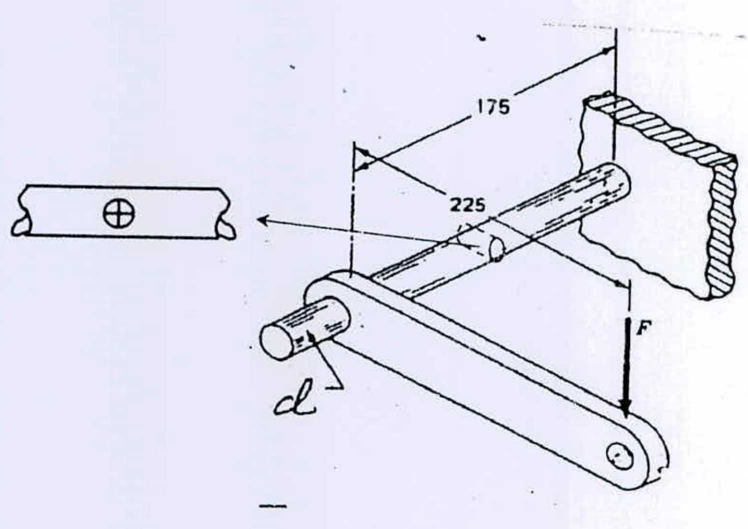

Fig. for Q. 7

L-3/T-2/ME **Date: 12/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2021

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

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** questions.

1. (a) The probability that a married man watches a certain television show is 0.4 and the probability that married women watches the show is 0.5. The probability that a man watches the show, given that his wife does, is 0.7. Find the probability that **(15)**

   (i) a married couple watches the show

   (ii) a wife watches the show given that her husband does

   (iii) at least, 1 person of a married couple will watch the show

   (b) The length of time, in minutes, for an airplane to obtain clearance for takeoff at a certain airport is a random variable y = 3x - 2, where x has the density function. **(10)**

$$f(x)=\begin{cases}\frac{1}{4}e^{-\frac{x}{4}} & x>0\\ 0, & Elsewhere\end{cases}$$

   Find the mean and variance of the random variable y

   (c) If a machine is set up correctly it produces 90 percent good items, if it is incorrectly setup then it produces 10 percent good items. Chances for a setting to be correct and incorrect are in the ratio of 7:3. After a setting is made, the first two items produced are found to be good items. What is the chance that the setting was correct? **(10)**

2. (a) Explain the characteristics of Exponential distribution. **(5)**

   (b) There are two vacancies in a certain university's statistics department. Six individuals apply. Two have expertise in linear models, and one has expertise in applied probability. The search committee is instructed to choose the two applicants randomly. **(5+5=10)**

   (i) What is the probability that the two chosen are those with expertise in linear models?

   (ii) What is the probability that of the two chosen, one has expertise in linear models and one has expertise in applied probability?

Contd P/2

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Contd... Q. No. 2

(c) A manufacturer of a certain type of large machine wishes to buy rivets from one of two manufacturers. It is important that the breaking strength of each rivet exeed 10,000 psi. Two manufacturers (A and B) offer this type of rivet and both have rivets whose breaking strength is normally distributed. The mean breaking strengths for manufacturers A and B are 14,000 psi and 13,000 psi, respectively. The standard deviations are 2000 psi and 1000 psi, respectively. Which manufacturer will produce, on the average, the fewest number of defective rivets? **(10)**

(d) The mean and variance of the binomial distribution b (x; n, p) are μ = np and σ^2 = npq. **(10)**

3. (a) Define hypothesis and hypothesis testing. Explain the required steps in conducting a test of hypothesis. **(10)**

(b) A new weight-watching company, Weight Reducers International, advertises that those who join will lose, on the average, 10 pounds the first two weeks. A random sample of 50 people who joined the new weight reduction program revealed the mean loss to be 9 pounds with a standard deviation of 2.8 pounds. At. the 0.05 Level of significance, can we conclude that those joining Weight Reducers on average will lose less than 10 pounds? **(10)**

(c) The mean time of workers who are employed in the downtown area spend getting to work is 30 minutes. The Greater Pittsburgh area chamber of commerce wants to analyze the meantime workers who are employed in the downtown area spend getting to work. A sample of 15 workers reveals the following number of minutes traveled. **(15)**

29, 38, 38, 33, 38, 21, 45, 34, 40, 37, 37, 42, 30, 29, 35.

Is it reasonable to conclude that there has been a change in the meantime of the workers? Use a 0.01 significance level.

4. (a) Explain what you mean by systematic error. How can you classify systematic error? **(7)**

(b) Describe the sources of errors that can be incorporated in angle measurement using sine bar. **(5)**

(c) Explain the advantages and disadvantages of mechanical-optical comparators. **(8)**

(d) Figure 4.1 exhibits a hole and shaft system. In order, the check whether the diameter of the hole is within the limit or not, the plug gauge showed in figure 4.2 is used. **(15)**

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Contd... Q. No. 4(d)

(i) What is the upper and lower limit of the hole diameter that the plug gauge can check?

(ii) If the shaft is identified as '$(ef)_g$' then what is the minimum and maximum clearance between the hole and shaft?

All the dimension are given in mm.

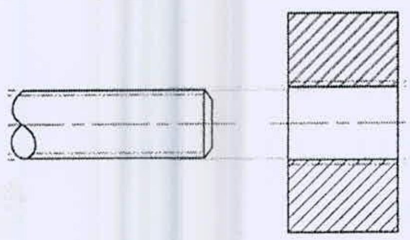

Fig 4.1: Hole and shaft system

Fig 4.2: Plug Gauge

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Find the tables required for obtaining the recommended values.
Assume appropriate values for missing data.

5. (a) What are the differences between destructive and nondestructive testing? Describe the cases where you can apply non-destructive testing. **(08)**

(b) Explain the magnetic particle testing method. What are the advantages and disadvantages of this method? **(09)**

(c) Derive an expression of the effective diameter of thread with respect to M, p, x, d using three wire method where M is the measurement over the wires, p is the pitch of the thread, x is the thread angle and d is the diameter of the wire. A Whitworth thread is being inspected using three wire method. Determine the effective diameter of the wire if M = 2.812 inch, p = 0.75 inch. Use the best sized wire diameter for the measurement. **(18)**

6. (a) What is an operating characteristic (OC) curve? How is it useful in acceptance sampling? Briefly explain each of the following terms: AQL, LTPD, Producer's risk, and Consumer's risk. **(15)**

(b) Write notes on the topics: **(05)**

(i) Difficulty in the elimination of natural causes than assignable causes

(ii) Use of $\overline{X}$ -S chart is preferable to $\overline{X}$ -R char

Contd P/4

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Contd... Q. No. 6

(c) The following data shows the actual demand for a certain product for 7 consecutive months. **(10)**

Month	1	2	3	4	5	6	7
Demand	76	80	83	90	85	86	98

Determine:

(i) Forecasted demand for month 9 using the linear regression technique

(ii) Correlation coefficient

(iii) Coefficient of Determination

(d) Prove that,

$$d = \frac{Nm}{2}\left[1 + \frac{2}{N} - \cos\left(\frac{90^o}{N}\right)\right]$$

in the case of gear measurement where all the term express their conventional meaning. **(05)**

7. (a) Describe the domains of the evolution of quality. **(12)**

(b) A company and its customer have agreed to follow a double sampling plan. The first sample size n_1 = 40 and the maximum allowable no. of nonconforming products for first sample c_1 = 2. For the second sample, n_2 = 80 and c_2 = 4. The lot size for this sampling plan, N = 3000. Calculate the total probability of acceptance in two trials when the value of the fraction of nonconforming is 0.05. **(15)**

(c) The range of upper and lower specification limits of a process is specified as 10σ. The actual process mean has shifted 1.5σ towards the upper specification limit. Conclude whether the process is capable or not. **(08)**

8. (a) Briefly explain the classification of cost of quality. **(06)**

(b) What is F distribution? Write down its characteristics. **(07)**

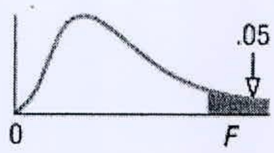
(c) Why do we need to study ANOVA? Explain with the help of an example. **(07)**

(d) Citrus Clean is a new all-purpose cleaner being test-marketed by placing displays in three different locations within various supermarkets. The number of 12-ounce bottles sold from each location within the supermarket is reported below. At the 0.05 significance level, is there a difference in the mean number of bottles sold at the three locations? **(15)**

Near Bread	Near Beer	Other Cleaners
18	12	26
14	18	28
19	10	30
17	16	32

=5=

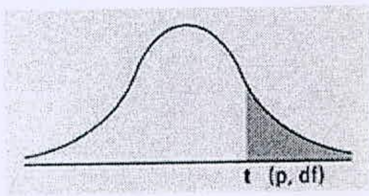
Table 1: F Distribution Table for α = 0.05



Degrees of Freedom for the Denominator	Degrees of Freedom for the Numerator: 1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251
2	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5
3	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39

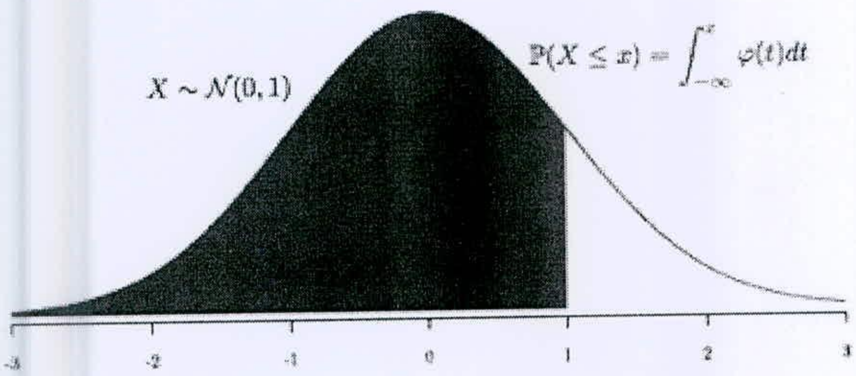
Table 2: Student t- distribution Probability Table

Numbers in each row of the table are values on a *t*-distribution with (*df*) degrees of freedom for selected right-tail (greater-than) probabilities (*p*).



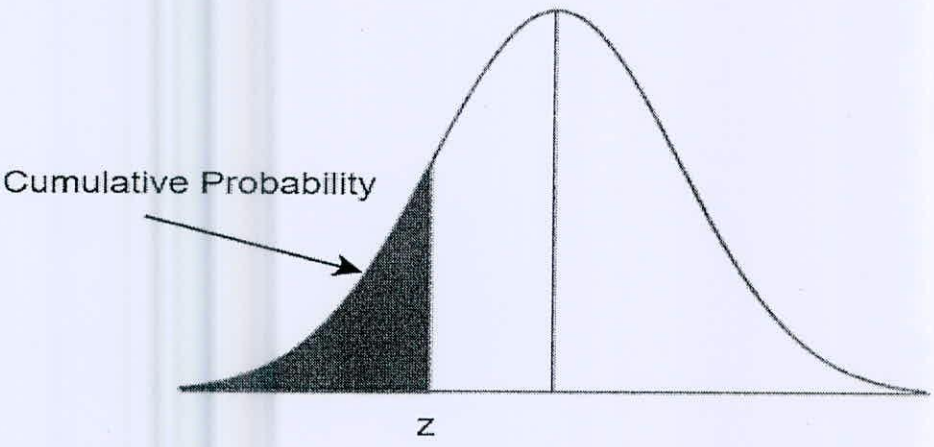
df/p	0.40	0.25	0.10	0.05	0.025	0.01	0.005	0.0005
1	0.324920	1.000000	3.077684	6.313752	12.70620	31.82052	63.65674	636.6192
2	0.288675	0.816497	1.885618	2.919986	4.30265	6.96456	9.92484	31.5991
3	0.276671	0.764892	1.637744	2.353363	3.18245	4.54070	5.84091	12.9240
4	0270722	0.740697	1.533206	2.131847	2.77645	3.74695	4.60409	8.6103
5	0.267181	0.726687	1.475884	2.015048	2.57058	3.36493	4.03214	6.8688
6	0.264835	0.717558	1.439756	1.943180	2.44691	3.14267	3.70743	5.9588
7	0.263167	0.711142	1.414924	1.894579	2.36462	2.99795	3.49948	5.4079
8	0.261921	0.706387	1.396815	1.859548	2.30600	2.89646	3.35539	5.0413
9	0.260955	0.702722	1.383029	1.833113	2.26216	2.82144	3.24984	4.7809
10	0260185	0.699812	1.372184	1.812461	2.22814	2.76377	3.16927	4.5869
11	0259556	0.697445	1.363430	1.795885	2.20099	2.71808	3.10581	4.4370
12	0259033	0.695483	1.356217	1.782288	2.17881	2.68100	3.05454	43178
13	0.258591	0.693829	1.350171	1.770933	2.16037	2.65031	3.01228	4.2208
14	0.258213	0.692417	1.345030	1.761310	2.14479	2.62449	2.97684	4.1405
15	0.257885	0.691197	1.340606	1.753050	2.13145	2.60248	2.94671	4.0728
16	0257599	0.690132	1.336757	1.745884	2.11991	2.58349	2.92078	4.0150
17	0.257347	0.689195	1.333379	1.739607	2.10982	2.56693	2.89823	3.9651
18	0.257123	0.688364	1.330391	1.734064	2.10092	2.55238	2.87844	3.9216
19	0.256923	0.687621	1.327728	1.729133	2.09302	2.53948	2.86093	3.8834
20	0.256743	0.686954	1.325341	1.724718	2.08596	2.52798	2.84534	3.8495
21	0.256580	0.686352	1.323188	1.720743	2.07961	2.51765	2.83136	3.8193
22	0256432	0.685805	1.321237	1.717144	2.07387	2.50832	2.81876	3.7921
23	0256297	0.685306	1.319460	1.713872	2.06866	2.49987	2.80734	3.7676
24	0.256173	0.684850	1.317836	1.710882	2.06390	2.49216	2.79694	3.7454
25	0.256060	0.684430	1.316345	1.708141	2.05954	2.48511	2.78744	3.7251
26	0.255955	0.684043	1.314972	1.705618	2.05553	2.47863	2.77871	3.7066
27	0.255858	0.683685	1.313703	1.703288	2.05183	2.47266	2.77068	3.6896
28	0.255768	0.683353	1.312527	1.701131	2.04841	2.46714	2.76326	3.6739
29	0.255684	0.683044	1.311434	1.699127	2.04523	2.46202	2.75639	3.6594
30	0.255605	0.682756	1.310415	1.697261	2.04227	2.45726	2.75000	3.6460

Table 3: Standard Normal Distribution Table (Positive Values)



	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Table 4: Standard Normal Distribution Table (Negative Values)



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Table 5: Fundamental deviations of various sizes of holes and shafts

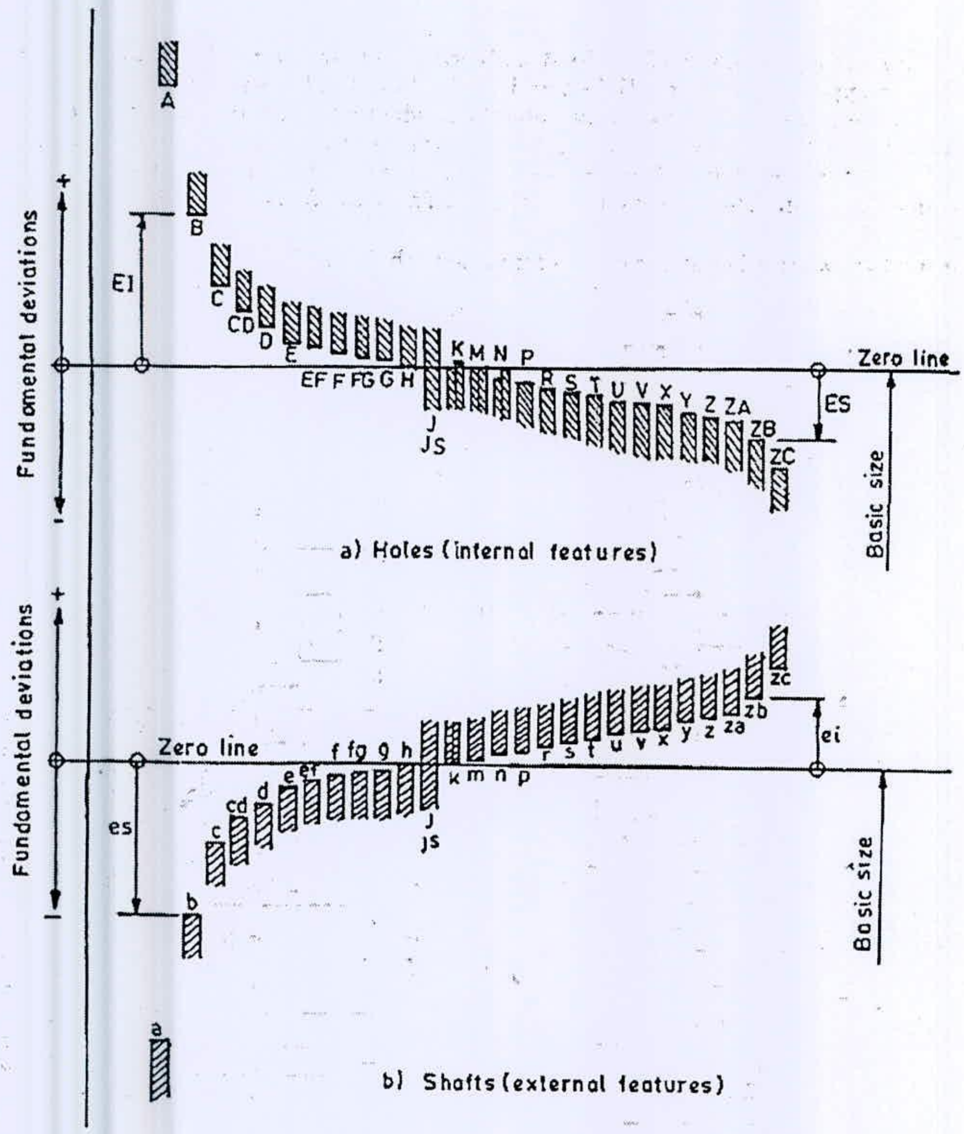


Table 6: Diameter ranges for nominal diameter value of hole and shaft

Table 7: Determination of fundamental deviations of various sizes of holes and shafts

Upper Deviation (es)	
Shaft Designation	*In microns (for D in mm)*
a	$= -(265 + 1.3D)$ for $D \le 120$ and $= -3.5D$ for $D > 120$
b	$= -(140 + 0.85D)$ for $D \le 160$; $= -1.8D$ for $D > 160$
c	$= -52D^{0.2}$ for $D \le 40$; $= -(95 + 0.8D)$ for $D > 40$
cd	G.M. of values for c and d
d	$= -16D^{0.44}$
e	$= -11D^{0.41}$
ef	G.M. of values for e and f
f	$= -5.5D^{0.41}$
fg	G.M. of values for f and g
g	$= -2.5D^{0.34}$
h	$= 0$

Lower Deviation (ei)	
Shaft Designation	*In microns (for D in mm)*
j	No formula
js	$IT/2$
$k4$ to $k7$	$= +0.6\sqrt[3]{D}$
k for grade ≤ 3 and ≥ 7	
m	$= +(IT7 - IT6)$
n	$= +5D^{0.34}$
p	$= +IT7 + 0$ to 5
r	= geometric mean of values for p and s
s	$= IT8 + 1$ to 4 for $D \le 50$; $= +IT7$ to $+0.4D$ for $D > 50$
t	$= +IT7 + 0.63D$
u	$= +IT7 + D$
v	$= +IT7 + 1.25D$
x	$= +IT7 + 1.6D$
y	$= +IT7 + 2D$
z	$= +IT7 + 2.5D$
za	$= IT8 + 3 + 3.15D$
zb	$= +IT9 + 4D$
zc	$= +IT10 + 5D$

Table 8: The relative magnitude of each tolerance grade for basic size up to 500mm

Grades	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16	IT17	IT18
Values	$7i$	$10i$	$16i$	$25i$	$40i$	$64i$	$100i$	$160i$	$250i$	$400i$	$640i$	$1000i$	$1600i$	$2500i$

L-3/T-II/ME **Date : 06/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **HUM 201** (Sociology)

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) What is sociological imagination? How can sociological imagination both limit and empower individuals in their ability to explain social relationships? **(15)**

   (b) What are the key principles and assumptions of the functionalist theoretical perspective and how do they explain the role and function of social institutions in maintaining social order and stability? **(20)**

2. (a) What is cultural lag? How does it describe the interrelationship between technological and social change in society? **(15)**

   (b) To what extent do subcultures and countercultures represent a form of resistance against social and political power structures, and how do these alternative forms of cultural expression contribute to the formation of individual and collective identities within diverse communities? **(20)**

3. (a) 'The history of all hitherto existing society is the history of class struggle' – explain this statement on the basis of Karl Marx's view of social stratification. **(15)**

   (b) What are the key difference between caste systems and social class systems in terms of their impact on individual life chances, social mobility, and power dynamics within societies? **(20)**

4. Write short notes on any three of the following: **(35)**

   (a) Agents of socialization

   (b) Types of social mobility

   (c) Types of socialization

   (d) Mead's theory of socialization

Contd P/2

HUM 201(ME)

SECTION – B

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

5. (a) How did the Industrial Revolution affect societal and cultural changes in Europe? **(20)**

   (b) Show push-pull motive and travel intentions for Bangladeshi migrants moving abroad. **(15)**

6. (a) How would you define deviance? How does a mismatch between institutional means and societal goals lead to deviance in society? **(20)**

   (b) Illustrate the major distinctions between new urban sociology and urban ecology. **(15)**

7. (a) "Although highly productive, mass societies are characterized by weak kinship, impersonal neighborhoods, social isolation, and moral ambiguity." Determine the social changes between traditional and mass society based on the statement. **(20)**

   (b) Define family. Describe various family types using appropriate examples. **(15)**

8. Write short notes on any THREE of the following: **(35)**

   (a) Population pyramid

   (b) Fatalism

   (c) Class struggle

   (d) Water pollution

L-3/T-2/ME **Date: 06/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2020-2001

Sub : **HUM 203** (Government)

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) Define nationalism. Describe the elements of nationalism. **(15)**

   (b) What is meant by sovereignty? Explain the characteristics of sovereignty with examples. **(20)**

2. (a) Define constitution. Analyze the qualities of a good constitution. **(15)**

   (b) Write on the concept of good governance? Discuss the problems of governance in developing countries. **(20)**

3. (a) What is the Legislature? Describe the functions of the Legislature in a state. **(15)**

   (b) Discuss the advantages and disadvantages of parliamentary government. **(20)**

4. Write short notes on any three (3) of the following: **(35)**

   (a) Qualities of a good citizen

   (b) Democracy

   (c) Unitary government

   (d) Language movement of 1952

SECTION – B

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

5. (a) What is local government? Discuss the functions of urban local government institutions in Bangladesh. **(15)**

   (b) What is bureaucracy? Write an analytical note on Max Weber's rational model of bureaucracy. **(20)**

6. (a) Discuss the significance of the basic principles of Bangladesh Constitution of 1972. **(15)**

   (b) Explain the determinants of the foreign policy of Bangladesh. **(20)**

7. (a) Explain key features of the political system of UK. **(15)**

   (b) Discuss the causes and consequences of military intervention in politics in developing countries. **(20)**

8. Write short notes on any three (3) of the following: **(35)**

   (a) Liberation war of Bangladesh (b) Political party (c) Socialism (d) UNO
