L-3/T-2/ME Date : 07/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2021-2022

Sub : **ME 323** (Fluid Mechanics 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**.

Moody diagram is supplied.

1. (a) Consider, an incompressible, steady, fully developed laminar flow of a fluid between two parallel plates separated by a distance h, The upper plate is moving with velocity U, and the lower plate is stationary. **(12)**

   (i) Derive an expression for the distribution of flow velocity between the plates.

   (ii) If $U = 0$, show that the average flow velocity between the plates is 2/3rd of the maximum velocity.

   (b) What is the origin of so-called "apparent shear stress" in a turbulent flow? What is eddy viscosity? **(6)**

   (c) The elevation of water level in a pond is 5 m. Water is to be transported at 0.012 m^3/s rate from this pond to a large reservoir with elevation of water level = 85 m. **(17)**

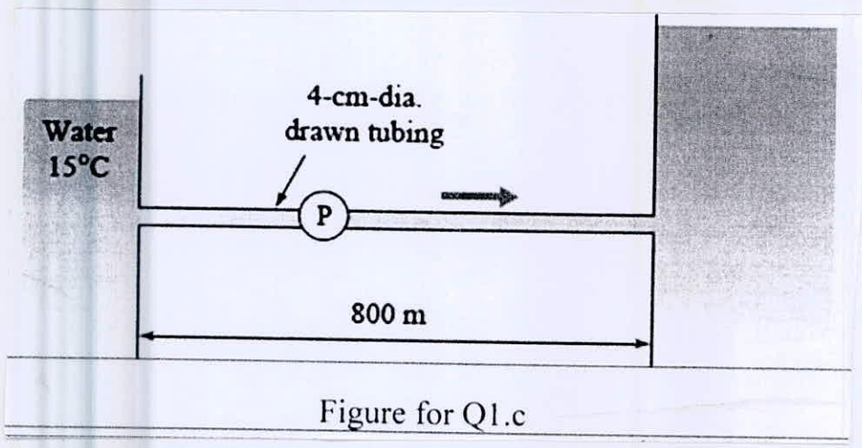


Figure for Q1.c

As shown in the Figure for Q1.c, a pump of 87% efficiency is fitted in the 800 m long horizontal pipeline that connects the pond and the reservoir. Determine (i) the pump power required, (ii) the greatest distance from the left reservoir where the pump can be located. Take kinematic viscosity of water = 1.14×10^{-6} m^2/s. Vapor pressure of water at 15°C is 1700 Pa abs.

2. (a) What is hydraulically smooth pipe? What is relative roughness? Why is the consideration of relative roughness very important in estimation of head loss in a turbulent flow? **(7)**

Contd P/2

ME 323

Contd...Q.NO. 2

(b) Water is transported at 0.05 m/s velocity through a smooth horizontal conduit of circular cross-section. The diameter of the conduit is 100 cm. Water depth in the conduit is 50 cm. Determine the hydraulic radius and the Reynolds number for this flow. **(8)**

(c) Two single-stage Ingersoll-Dresser 15H277 pumps outfitted with the largest available impeller is used in parallel to pump water from a reservoir at elevation 1350 ft to another reservoir at 1425 ft. The line is 7000 ft long and 18 in. in diameter with an equivalent sand grain roughness e = 0.015 in. The kinematic viscosity is 1.14×10^{-5} ft^2/s. Neglecting minor losses compute the discharge in the pipeline. The performance curves of the pumps is shown in Figure for Q2.c. Use 1 ft^3/s = 449 US GPM. **(20)**

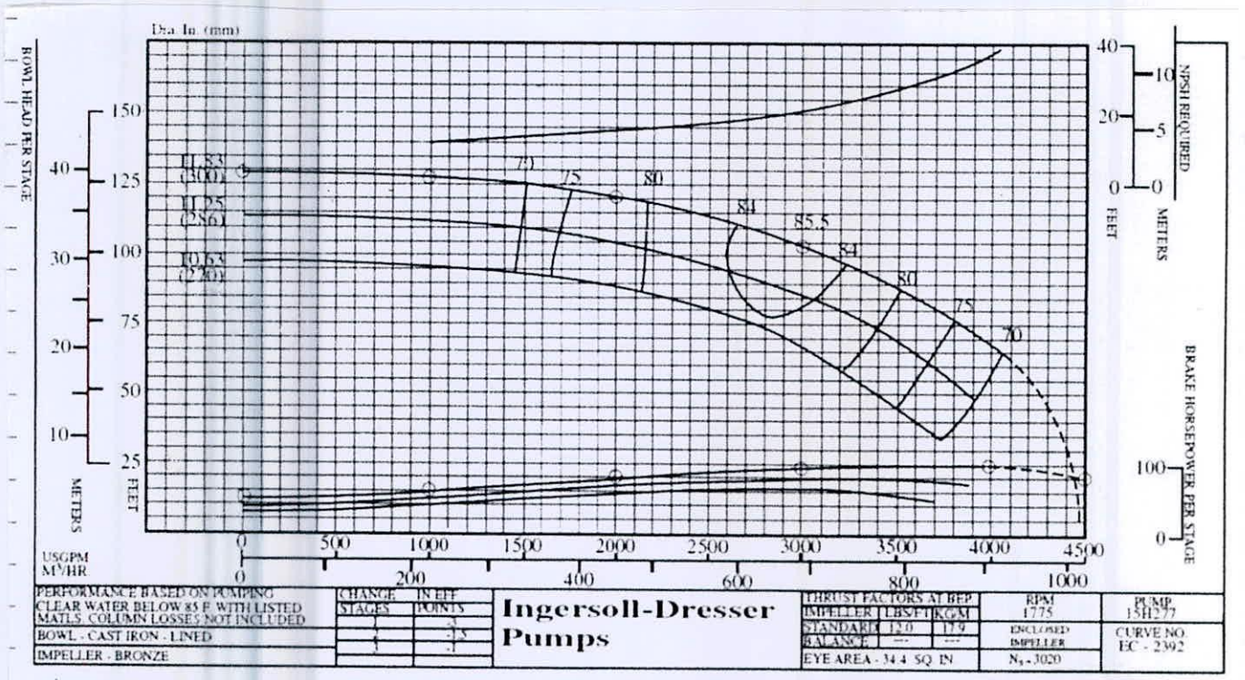


Figure for Q2.c

3. (a) What is minor loss? What is the origin of minor loss? Explain with necessary sketches. **(7)**

(b) A pipeline consists of two pipe segments in series (Figure for Q3.b). The specific gravity of the fluid is 0.85. If pump A has a constant power input of 1 MW, find the discharge, the pressure head in pumps A and B, and the required power for pump B. The minimum allowable pressure on the suction side of pump B is 150 kPa, and both pumps have an efficiency of 80%. The pipeline data are shown below: **(28)**

Pipe	*L*(m)	*D*(mm)	$\sum K$	*f*
1	5000	750	2	0.023
2	7500	750	10	0.023

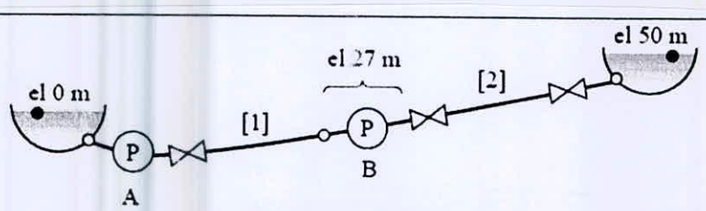


Figure for Q3.b

Contd P/3

ME 323

4. (a) The equilateral-triangle channel in Figure for Q4.a has constant slope S_0 and constant Manning factor n. If $y = a/2$, find an analytic expression for the flow rate Q. **(11)**

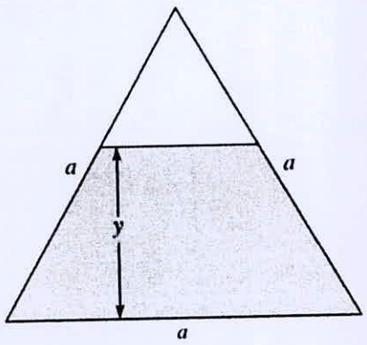


Figure for Q4.a

(b) What is hydraulic jump? Water flows in a rectangular channel with a velocity of 2.5 m/s and a depth of 1 m. A gate is suddenly completely closed forming a surge that travels upstream. Find the speed of the surge and the depth of flow behind the surge. **(12)**

(c) Design a broad-crested weir to convey a river discharge that varies between $Q_1 = 0.15$ m^3/s and $Q_2 = 30$ m^3/s. The maximum water depth upstream of the weir is not to exceed $y_2 = 1.75$ m and the minimum depth is not to be less than $y_1 = 1.05$ m. **(12)**

SECTION – B

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

5. (a) A researcher is interested in how fish propel themselves through water by oscillating their fins. The researcher considers a class of geometrically similar fish and observes that the thrust F which a fish generates depends on the length L of the fish, the density ρ of the water, the speed V with which it moves through the water and the frequency f with which it oscillates its tail fins (see Fig. for Q. 5(a)). **(20)**

(i) Using dimensional analysis, define a dimensionless thrust and determine the dimensionless variables on which it depends.

(ii) In a set of experiments in water ($\rho = 1000$ kg/m^3), the researcher measures the thrust developed by a baby marlin ($L = 0.1$ m) as it moves at a speed of $V = 0.1$ m/s, as given in Table for Q. 5(a). Based on these data, determine the exact functional relationship found in part (i).

Table for Q. 5(a)

f(Hz)	F(mN)
1	2.54
2	5.16
3	7.86
5	13.5
10	29.0

Contd P/4

ME 323

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

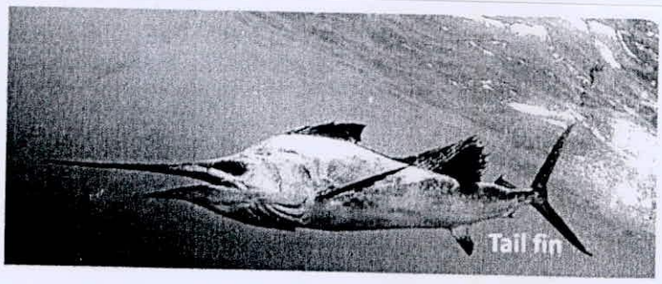


Fig. for Q. 5(a)

(b) A long structural component of a bridge has an elliptical cross section shown in Fig. for Q. 5(b). It is known that when a steady wind blows past this type of bluff body, vortices may develop on the downwind side that are shed in a regular fashion at some definite frequency. Since these vortices can create harmful periodic forces acting on the structure, it is important to determine the shedding frequency. For the specific structure of interest, D = 0.5 m, H = 1.5 m, and the wind velocity, V is 80 km/hr. Standard air can be assumed. The shedding frequency is to be determined through the use of a small-scale model that is to be tested in a water tunnel. For the model D_m = 100 mm and the water temperature is 20°C. **(15)**

(i) Determine the model dimension, and the velocity at which the test should be performed.

(ii) If the shedding frequency, f for the model is found to be 49.9 Hz, what is the corresponding frequency for the prototype?

$$\left[\text{Hints}: \text{St} = f\left(\frac{H}{D}, \text{Re}\right);\ \text{where St} = \text{Strouhal number} = \frac{fD}{V} \text{ and } \text{Re} = \frac{\rho VD}{\mu}\right]$$

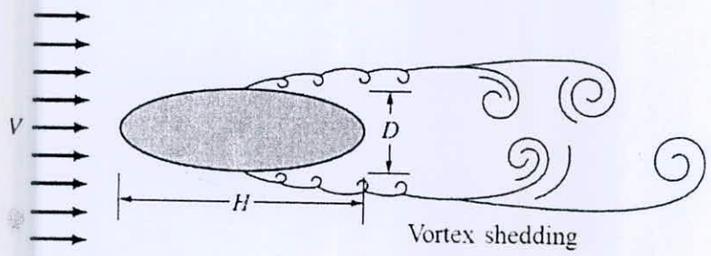


Fig. for Q. 5(b)

6. (a) A convergent nozzle with exit area 5 cm^2 is attached to the exhaust of an aircraft engine as shown in Fig. for Q. 6(a). The exhaust gas is supplied from a combustion chamber in which the pressure is 180 kPa and the temperature is 1400 K. Calculate the mass flow rate through the exhaust nozzle and available thrust for back pressures of **(15)**

(i) 140 kPa

(ii) 80 kPa

(iii) 20 kPa

Assume isentropic flow through the exhaust nozzle and

$k_{\text{exhaust gas}}$ = 1.4, $R_{\text{exhaust gas}}$ = 0.287 kJ/(kg K)

Contd P/5

ME 323

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

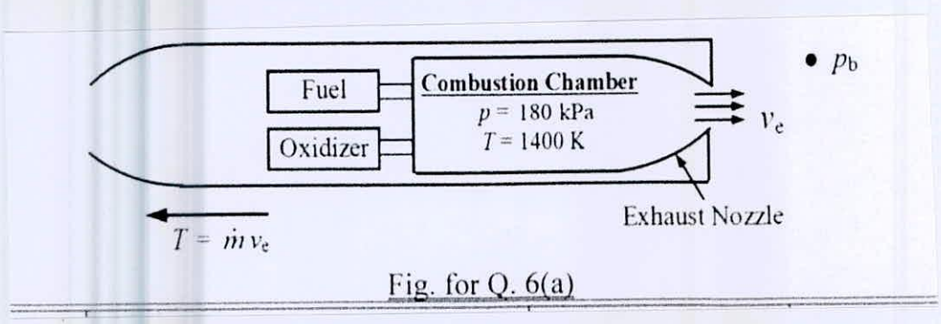


Fig. for Q. 6(a)

(b) A sharp-nosed projectile travels at an elevation of 600 m above the ground as shown in Fig. for Q. 6(b). Consider the scenario in which the projectile travels at a Mach number of 2.5 and the ambient temperature is 15°C. What is the velocity of the projectile? What is the distance L when a sound detector or the ground first "hears" the projectile? **(10)**

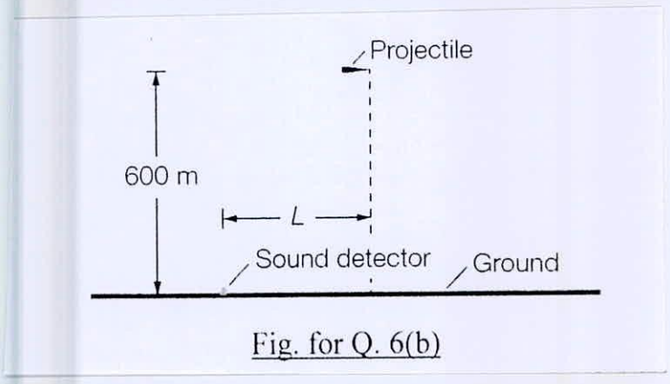


Fig. for Q. 6(b)

(c) Draw the typical distribution of static pressure, total pressure and Mach number along the axial direction of a converging-diverging nozzle in cases of **(10)**

(i) Overexpansion

(ii) Underexpansion

7. (a) Derive an expression to theoretically predict the local Mach number with respect to expansion ratio (ε) for isentropic flow of compressible fluid through a variable area passage. Simplify this expression for the case of air flow (k = 1.4) What are the possible Mach numbers at a section where the expansion ratio is 2.3 for isentropic flow of air? **(15)**

(b) Air flows through a converging-diverging nozzle between two large reservoirs, as shown in Fig. for Q. 7(b). A mercury manometer reads h = 15 cm. **(20)**

(i) Estimate the downstream reservoir pressure.

(ii) Is there a shock wave in the flow? If so, does it stand in the exit plane or farther upstream?

(iii) Estimate the mass flow rate for the given condition.

(iv) What would be the mercury manometer reading if the nozzle was operating exactly at supersonic design condition? Also, estimate the corresponding mass flow rate.

Contd P/6

ME 323

Contd...Q.No. 7(b)

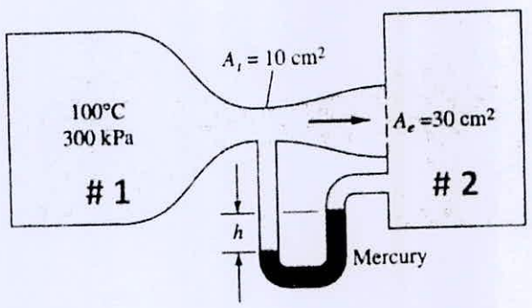


Fig. for Q. 7(b)

8. (a) The laminar velocity profile inside the boundary layer on a flat plate can be approximated by the following relation. **(15)**

$$\frac{u(y)}{U_\infty} = \begin{cases} 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2 & \text{for } 0 \le y \le \delta \\ 1 & \text{for } y > \delta \end{cases}$$

where the symbols have their usual meaning.

Estimate the growth of laminar boundary layer thickness and momentum thickness with distance from plate leading edge (0, 0).

(b) How does the pressure gradient affect the boundary layer development over a solid surface? Briefly explain with sketches showing the separation and reattachment points. **(7)**

(c) A light airplane weighs 12 kN, its wingspan measures 15 m, chord measures 2.4 m, and a payload of 3 kN is anticipated. Predict, **(13)**

(i) the takeoff speed if an angle of attack of 8° is desired,

(ii) the stall speed of the conventional airfoil, and

(iii) the power required by the airfoil during cruise at 340 km/h. Consider design C_L = 0.3

Necessary data can be taken from Fig. for Q. 8(c)

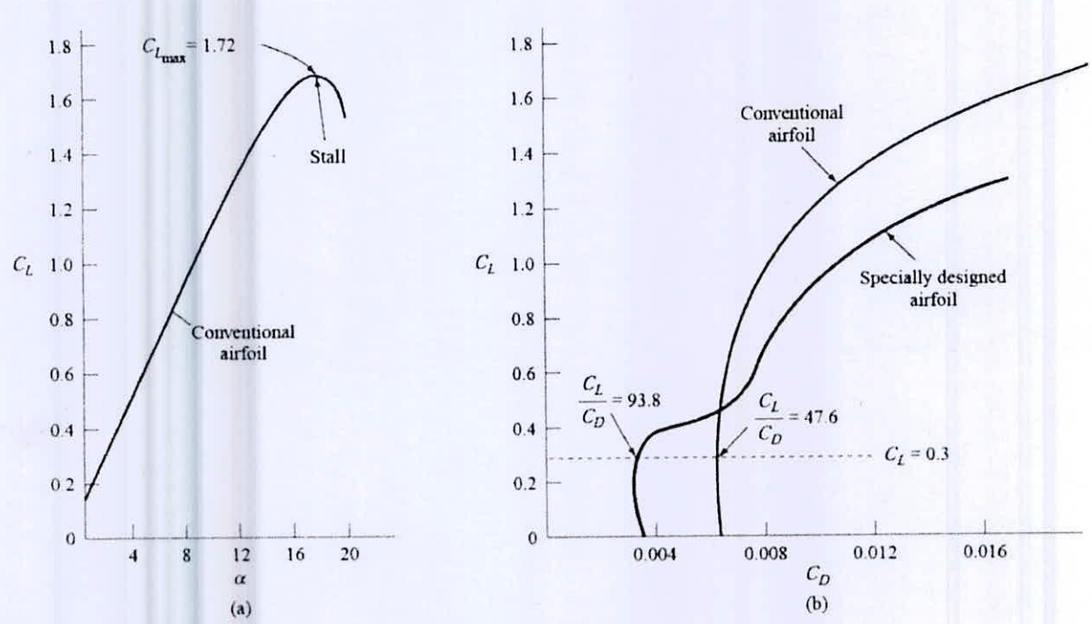


Fig. for Q. 8(c)

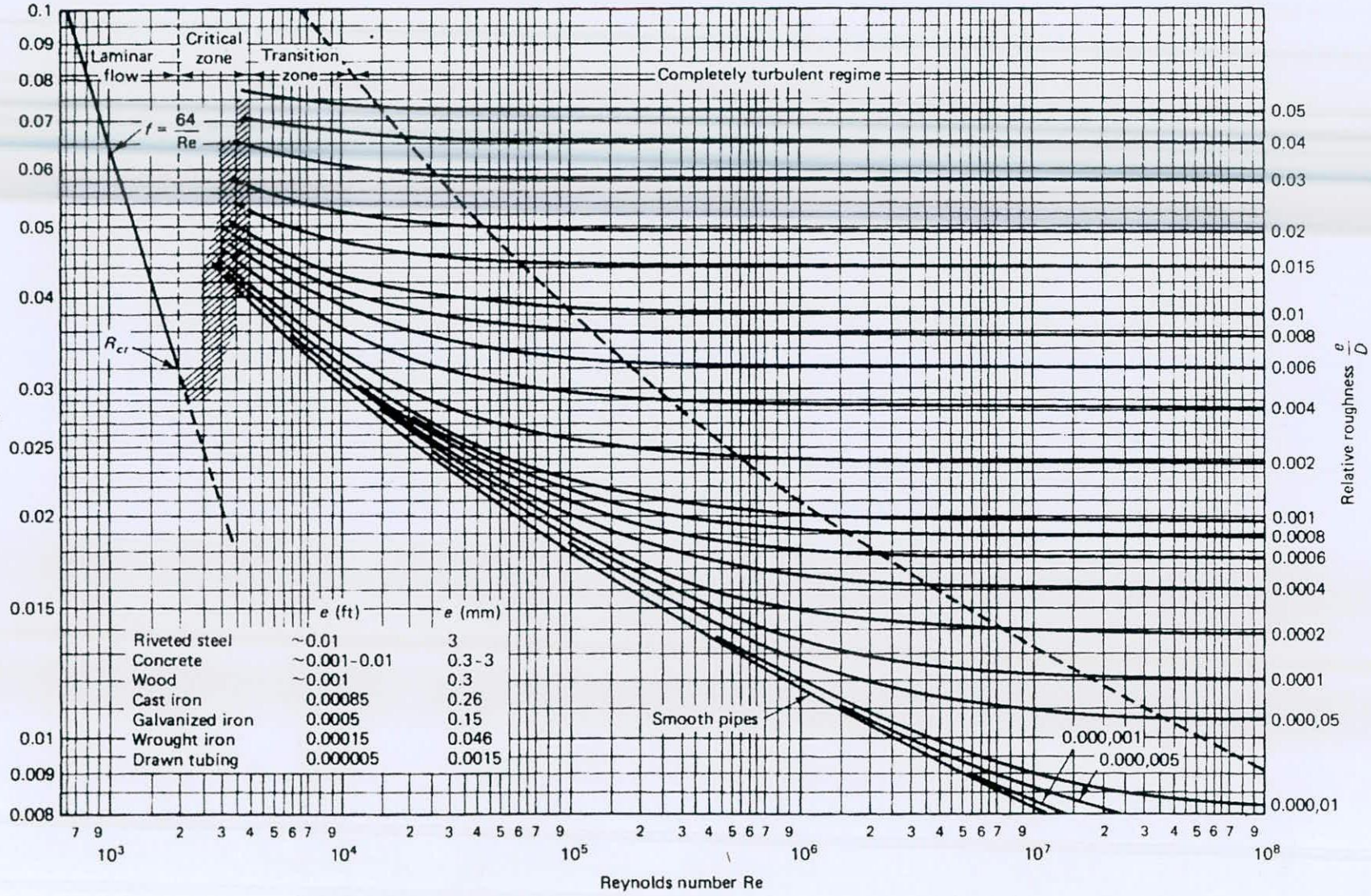


Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations 2021-2022

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

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks.

Shigley's Mechanical Engineering Design textbook will be supplied. Assume reasonable values for the missing data to solve problems, if required.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) An overhung diving board is shown in Figure 1(a). Assume cross-sectional dimensions of 305 mm × 32 mm. Find the largest principal stress in the board when a 100-kg person is standing at the free end. What is the static safety factor if the material is brittle fiberglass with $S_{ut} = S_{uc} = 130$ MPa? Use a suitable failure theory. **(16⅔)**

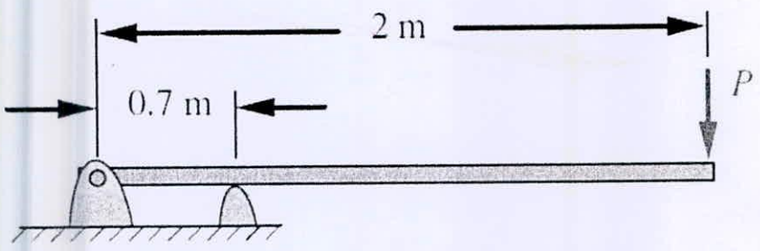


Fig. for Q. 1(a)

(b) A rotating shaft has been designed and fabricated from SAE 1040 HR steel. It is made from tubing that has an outside diameter of 60 mm and a wall thickness of t mm. Strain gage measurements indicate that there is a fully reversed axial stress of 68 MPa and a torsional stress that fluctuates from 12 MPa to 52 MPa in phase with the axial stress at the critical point on the shaft. There is a 3 mm radius notch on the tube surface with a S.C.F. of 1.4 for both the loading types. Determine the thickness t, if the infinite-life fatigue safety factor is 2 for the shaft and the reliability is 99%. **(30)**

2. A 21-tooth pinion rotating at 1800 rpm meshes with a 33-tooth gear in a spur-gear reducer. Both pinion and gear are manufactured to a quality level of 9. A reliability of 0.9 has been specified, and the transmitted tangential load is 2800 lb_f. Conditions are such that $K_m(K_H) = 1.7$. It is proposed that standard 20°, full-depth teeth be used, with both pinion and gear hobbed from an AISI 4140 nitrided steel (Grade-1, BHN = 300). The diametral pitch is 6, and the face width is 2.0 in. Estimate the number of cycles of bending and contact (surface) stresses (using the AGMA equations, $S_F = 2$) that the gearset can withstand. 1 $lb_f = 4.45$ N. **(46⅔)**

Contd P/2

ME 351

3. (a) A paper machine processes rolls of paper having a density of 984 kg/m^3. The paper roll is 1.50-m OD × 22-cm ID × 3.23-m long and is on a simply supported, 22-cm OD, steel shaft. The roll turns at 50 rpm. Design suitable hydrodynamically lubricated full-film bronze short bearings of l/d = 0.75 to support the shaft at each end. Specify: (i) radial clearance, c (ii) SAE number of lubricating oil (iii) maximum temperature rise, and (iv) minimum film thickness. **(30)**

   (b) A 02-series single-row deep-groove ball bearing with a 65-mm bore is loaded with a 3-kN axial load and a 7-kN radial load. The outer ring rotates at 500 rev/min. Determine whether this bearing should be expected to carry this load with a 95 percent reliability for 10 khr. **(16⅔)**

4. (a) A 90° straight bevel gearset is needed to give a 3:1 reduction. Determine the pitch cone angles and pitch diameters if the 20° pressure angle pinion has 15 teeth of diametral pitch, p_d = 6 teeth/in. The pinion has 550 rpm. The gear pair has 20 mm face width, through-hardened to 300 BHN (Grade-1). Assume the gears are for general industrial use, are generated to a transmission accuracy number of 5, and are uncrowned. What would be the power rating of this gearset considering bending stresses? Consider 10^7 load cycles with 99% reliability. **(26⅔)**

   (b) A temporary construction elevator is to be designed to carry workers and materials to a height of 30 m. The maximum estimated load to be hoisted is 2500 kgf at a velocity not to exceed 0.6 m/s. For minimum sheave diameters and acceleration of 1.2 m/s^2, specify the number of ropes required if the 25 mm plow-steel 6 × 19 hoisting strand is used. **(20)**

SECTION – B

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

Symbols used have their usual meaning and interpretation.

5. 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 casing. Given, ϕ_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. The resultant force on gear is designed based on temperature rise of the gear casing. The maximum allowable temperature rise is 20.6°F for the casing. **(46⅔)**

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

Contd P/3

ME 351
Contd... Q. No. 5

Find: (i) Resultant force on gear, (ii) rated power of the motor, (iii) safety factor by AGMA equation and (iv) gear rpm.

Use AGMA equation for finding friction coefficient f. Assume the worm shaft carries a fan and $A = 1.25\ A_{min.}$

6. (a) A fit is specified as 350 mm H7/n6

(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 15% of the holes were rejected being less than specifications, and 15% of the pins were rejected being more than specifications what was the smallest and largest pin dia that were made? Assume normal probability distribution. **(22⅔)**

(b) A centrally loaded, fixed-fixed steel column has to fulfill following design data: Cross-section is equal leg angle (203×76 mm), material: G10350 CD, Young's modulus 210 GPa, unsupported length = L mm. **(24)**

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

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

7. (a) A squared & ground helical compression spring is to meet following design requirements: spring index = 10, mean coil dia = 50 mm, active turn number = 10, material is 302 SS (un-peened), loads: F_m = 400N, F_a = 200 N, $\gamma = 82 \times 10^{-6}$ N/mm^3. Find:

(i) fatigue safety factor by Sine's theory (ii) Free length for which buckling is imminent (iii) fundamental natural frequency. Use Zimmerli's data. **(22⅔)**

(iv) Also plot load-deflection curve for the spring.

(b) A leaf spring (S_{ut} = 700 MPa) has 20 leaves each of width b = 20 mm and thickness h = 10 mm. The main leaf has a span of $L = 2l$ = 600mm. The spring supports a total vertical load of 2P = 12 kN so that half of this load (P) acts on each tip (eye). **(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 = 1.8 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.

Contd P/4

ME 351

8. (a) A square threaded power screw has following particulars: d = 36 mm, pitch p = 4 mm (triple threaded). Assume, $f = f_C = 0.1$, friction dia for collar $d_c = 1.25d$, load F = 20 kN. Find: Mechanical advantage (MA) and efficiency (e) of the power screw during raising the load. Collar friction is present. **(22⅔)**

   (b) An Al cylinder is connected to its head of same thickness (t = 50 mm) by 4 identical steel bolts (M30, coarse pitch, property class 8.8). Given, L =125mm, for a grip l = 100 mm. **(24)**

   (i) Assume E = 70 GPa for Al and calculate the member stiffness k_m.

   (ii) Given, joint constant c = 0.33, find bolt stiffness k_b.

   (iii) If separation of joint starts at 90% of proof load, find the pretension and required torque for each bolt. Assume zinc plated nut bolt assembly.

   (iv) Find the clamping force if the applied tensile load P is 90% of P_0.

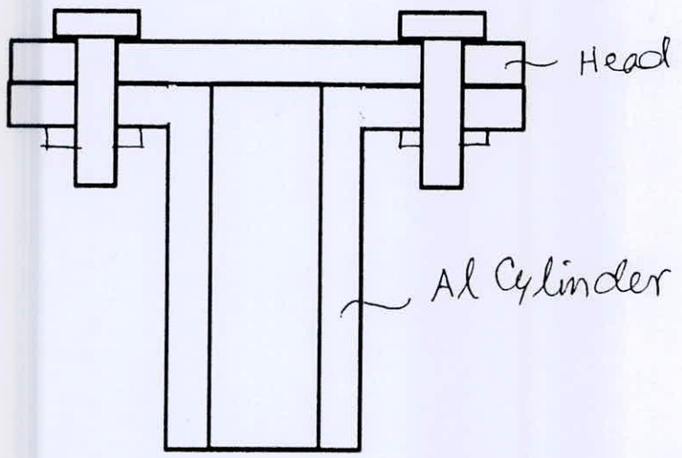


Fig. for Q. 8(b)

L-3/T-2/ME Date : 18/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2021-2022

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) Discuss the major historical events and intellectual movements that contributed to the emergence and development of sociology as a discipline. **(20)**

   (b) Critically examine the key principles and assumptions of the functionalist theoretical perspective of sociology. **(15)**

2. (a) Define social stratification. **(5)**

   (b) Demonstrate the aspects of caste system and social class system. **(15)**

   (c) Briefly discuss Karl Marx' theory of social differentiation. **(15)**

3. (a) Explain Charles Horton Cooley's looking glass-self theory. **(15)**

   (b) How does socialization shape human behavior? Write your answer highlighting the roles of different agents of socialization. **(20)**

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

   (a) Sub culture, counter culture and ethnocentrism.

   (b) Absolute poverty and relative poverty,

   (c) Sociological imagination,

   (d) Steps of social research.

SECTION – B

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

5. (a) Briefly differentiate between nuclear and joint families. Identify the root causes of the disintegration of joint family in Bangladesh. **(20)**

   (b) What lessons can be drawn from the historical study of the Industrial Revolution for our understanding of contemporary issues related to social and cultural change? **(15)**

6. (a) How did Marx view class struggle as the driving force of historical change? Privide a critical explanation of Marxist philosophy in the context of the development of capitalism in Europe. **(20)**

Contd P/2

HUM 201(ME)
Contd...Q.No. 6

(b) How can culture, conflict, and ideas bring about social change? Discuss the socio-cultural characteristics of modern society. **(15)**

7. (a) What do you mean by internal migration? How do climate change and other factors influence internal migration in Bangladesh? **(20)**

(b) Define juvenile delinquency. Elaborate the key sociodemographic factors associated with juvenile delinquency in Bangladesh. **(15)**

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

(a) Industrious revolution

(b) British industrial empire

(c) Cyber crime

(d) Total Fertility Rate (TFR)

L-3/T-2/ME **Date : 18/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2021-2022

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) What is nationalism? Discuss the merits of nationalism. **(15)**

   (b) Critically analyse the different theories of the origin of the state. **(20)**

2. (a) Define citizen. Examine the methods for acquiring citizenship. **(15)**

   (b) What is right? Explain the legal rights and duties of a citizen in a state. **(20)**

3. (a) Who are the executives? Discuss the role and functions of the executives in a state. **(15)**

   (b) Make a comparative discussion between parliamentary and Presidential form of government. **(20)**

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

   (a) Rational model of bureaucracy
   (b) Rule of law
   (c) Political sovereignty
   (d) Limitations of democracy

SECTION – B

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

5. (a) What is public opinion? Discuss the agents of public opinion in a democratic society. **(15)**

   (b) What do you know about the language movement of 1952? Explain the consequences of language movement. **(20)**

6. (a) Discuss the major characteristics of the Bangladesh constitution of 1972. **(15)**

   (b) Define local government. Discuss the functions of urban local government in Bangladesh. **(20)**

7. (a) Describe the internal and external determinants of the foreign policy of Bangladesh. **(15)**

   (b) Discuss the six organs of the united nations organization. **(20)**

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

   (a) Public Service Commission (PSC)
   (b) Election Commission
   (c) Auditor-General
   (d) Good Governance

L-3/T-2/ME Date : 12/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2021-2022

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) Derive an expression of the effective diameter of a thread with the two-wire method. A metric screw thread is being inspected using the two-wire method to measure its effective diameter, and the following data is generated: pitch = = 1.5 mm, diameter of the best size wire = 0.866 mm, distance over the wires = 26.58 mm, and thread angle = 60°. Determine the effective diameter of the screw thread. **(12+3)**

   (b) Is the major diameter of a screw thread larger than the minor diameter for both external and internal thread? Justify your answer with suitable sketches. **(10)**

   (c) Differentiate between a Cup Anemometer and Plate Anemometer. Mention the applications of an Anemometer. **(10)**

2. (a) Briefly describe the different properties of measuring instruments with necessary sketches. **(15)**

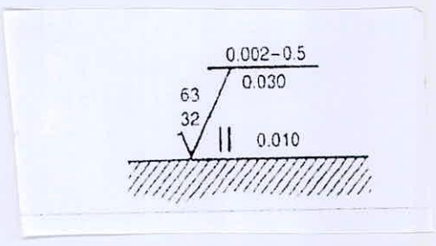
   (b) Calculate the limits of tolerance and allowance for a 29 mm shaft and hole pair designed H_8h_8, where the fundamental tolerance is 25 times of the tolerance factor and diameter step is between 18 to 30 mm. **(10)**

   (c) If the base pitch is 8.86 mm and the radius of the base circle is 33.83 mm, determine the number of teeth of the gear. Why dedendum is larger than addendum for a gear? Explain with the necessary figures. **(5+5)**

3. (a) What are the differences between destructive and nondestructive testing (NDT)? Which NDT method is being used to detect surface or subsurface flaws, as well as to asses conductivity and coating thickness? Write a short note on this NDT method. **(5+10)**

   (b) Briefly describe the working principle, advantages and disadvantages of the Venturimeter. **(10)**

   (c) Explain different categories of surface irregularities with neat sketches. Identify the symbolic representations of the following figure. **(7+3)**



Contd P/2

IPE 381

4. (a) What is acceptance sampling? Briefly describe AQL, LTPD, and OC in acceptance sampling. **(15)**

(b) What do you understand by Total Quality Management (TQM)? Briefly discuss the main distinguishing characteristics of TQM. **(10)**

(c) A company produces a component of the hard disk of computer. The length of the component is important. While the target length of the components is 10 cm, marginal variation is acceptable. The specification states that any length between 8.5 cm to 11 cm is acceptable. The historical data shows that lengths are normally distributed with a standard deviation of 5 mm. The company produces 8000 components a day. In a workday, total how many components are expected to be accepted and how many are rejected? Show the associated diagrams. It is essential to take up to 4 points/digits after the decimal point. **(10)**

SECTION – B

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

5. (a) In a high school graduating class of 100 students, 54 studied mathematics, 69 studied history, and 35 studied both mathematics and history. If one of these students is selected at random, find the probability that **(9)**

(i) The student took mathematics or history;

(ii) The student did not take eighter of these subjects;

(iii) The student took history but not mathematics.

(b) A private pilot wishes to insure an airplane for $200,000. The insurance company estimates that a total loss will occur with probability 0.001, a 50% loss with probability 0.01, and a 25% loss with probability 0.2 Ignoring all other partial losses, what premium should the insurance company charge each year to realize an average profit of $500? **(12)**

(c) An experiment is conducted where 3 electric components are tested to check whether they are defective or not. The components are selected independently and among them 25% are defectives. The probability distribution of defective components is: **(14)**

x	0	1	2	3
f(x)				

Complete the table.

6 (a) The probability that a person will die when he or she contracts a viral infection is 0.004. Of the next 4000 people infected, what is the mean number who will die? **(5)**

(b) A manufacturing company uses an acceptance scheme on items from a production line before they are shipped. The plan is a two-stage one. Boxes of 25 items are readied for shipment and a sample of 3 items is tested for defectives. If any defectives are found, the entire box is sent back for 100% screening. If no defectives are found, the box is shipped

(i) What is the probability that a box containing 3 defectives will be shipped? **(10)**

(ii) What is the probability that a box containing only 1 defective will be sent back for screening?

Contd P/3

IPE 381

Contd...Q.No. 5

(c) For a certain type of copper wire, it is known that, on average, 1.2 flaws occur per millimeter, what is the probability that no flaws occur in a certain portion of wire of length 5 millimeters? **(10)**

(d) The inside diameter of the washers produced by a certain company is normally distributed with a mean of 0.60 centimeters and standard deviation of 0.004 centimeters. **(10)**

(i) What percentage of the washers have an inside diameter of more than 0.61 centimeters?

(ii) Below what value of the inside diameter will 20% of the washers fall?

7. (a) It is claimed by an automobile company that the average mileage for a particular model of their diesel car is more than 22 kilometers/liter. To test this claim, 100 randomly selected car owners were asked to keep a record of the mileage of their cars. Would you agree with this claim if the average mileage from the random sample came up to 22.4 kilometers/liter, with a standard deviation of 1.2 kilometers/liter? Use 0.001 significance level. **(10)**

(b) Six different machines are being considered for use in manufacturing rubber seals. The machines are being compared with respect to tensile strength of the product. A random sample of four seals from each machine is used to determine whether the mean tensile strength of four seals from each machine is used to determine whether the mean tensile strength varies from machine to machine. The following are the tensile-strength measurements in kilograms per square centimeter $\times 10^{-1}$. **(20)**

Machine					
1	2	3	4	5	6
17.5	16.4	20.3	14.6	17.5	18.3
16.9	19.2	15.7	16.7	19.2	16.2
15.8	17.7	17.8	20.8	16.5	17.5
18.6	15.4	18.9	18.9	20.5	20.1

Perform the analysis of variance at the 0.05 level of significance and indicate whether or not the mean tensile strengths differ significantly for the six machines.

(c) Explain the characteristics of log normal distribution. **(5)**

8. (a) Explain the characteristics of chi-square distribution. **(5)**

(b) The following measurements were recorded for the drying time, in hours, of a certain brand of latex paint

3.4	2.5	4.8	2.9	3.6	2.8	3.3	5.6
3.7	2.8	4.4	4.0	5.2	3.0	4.8	

Assuming that the measurements represent a random sample from a normal population, find a 95% prediction interval for the drying time for the next trial of the paint. **(10)**

(c) A study was made on the amount of converted sugar in a certain process at various temperatures. The data were coded and recorded as follows: **(20)**

Contd P/4

IPE 381

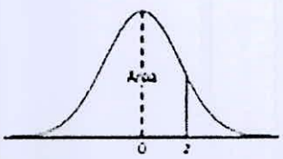
Contd...Q.No. 8(b)

Temperature	Converted Sugar
1.0	8.1
1.1	7.8
1.2	8.5
1.3	9.8
1.4	9.5
1.5	8.9
1.6	8.6
1.7	10.2
1.8	9.3
1.9	9.2
2.0	10.5

(i) Determine the coefficient of correlation and comment on the relationship between two variables.

(ii) Estimate the mean amount of converted sugar produced when the coded temperature is 1.75.

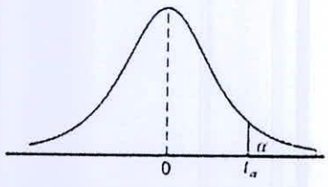
Table A.3 Areas under the Normal Curve



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Cumulative Areas under the Normal Curve

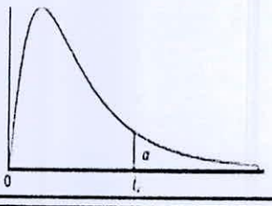
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	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
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998



Critical Values of the t-Distribution

	α						
v	0.40	0.30	0.20	0.15	0.10	0.05	0.025
1	0.325	0.727	1.376	1.963	3.078	6.314	12.706
2	0.289	0.617	1.061	1.386	1.886	2.920	4.303
3	0.277	0.584	0.978	1.250	1.638	2.353	3.182
4	0.271	0.569	0.941	1.190	1.533	2.132	2.776
5	0.267	0.559	0.920	1.156	1.476	2.015	2.571
6	0.265	0.553	0.906	1.134	1.440	1.943	2.447
7	0.263	0.549	0.896	1.119	1.415	1.895	2.365
8	0.262	0.546	0.889	1.108	1.397	1.860	2.306
9	0.261	0.543	0.883	1.100	1.383	1.833	2.262
10	0.260	0.542	0.879	1.093	1.372	1.812	2.228
11	0.260	0.540	0.876	1.088	1.363	1.796	2.201
12	0.259	0.539	0.873	1.083	1.356	1.782	2.179
13	0.259	0.538	0.870	1.079	1.350	1.771	2.160
14	0.258	0.537	0.868	1.076	1.345	1.761	2.145
15	0.258	0.536	0.866	1.074	1.341	1.753	2.131
16	0.258	0.535	0.865	1.071	1.337	1.746	2.120
17	0.257	0.534	0.863	1.069	1.333	1.740	2.110
18	0.257	0.534	0.862	1.067	1.330	1.734	2.101
19	0.257	0.533	0.861	1.066	1.328	1.729	2.093
20	0.257	0.533	0.860	1.064	1.325	1.725	2.086
21	0.257	0.532	0.859	1.063	1.323	1.721	2.080
22	0.256	0.532	0.858	1.061	1.321	1.717	2.074

Critical Values of the F-Distribution



$f_{0.05}(v_1, v_2)$

	v_1								
v_2	1	2	3	4	5	6	7	8	9
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28