BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **IPE 307** (Operations Research)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Distinguish between *engineering design* and *engineering analysis* using a suitable example. **(10)**

(b) Check for convexity of the following function. If the function is not convex everywhere, then determine the domain (feasible set S) over which the function is convex. **(11)**

$$f(x_1x_2) = 5x_1 - \frac{1}{16}x_1^2x_2^2 + \frac{1}{4x_1}x_2^2$$

(c) Write KKT necessary conditions and solve them for the problem **(25 2/3)**

Minimize $F(x_1, x_2) = 2x_1 + x_2 - x_1^2 - x_2^2 - 2$

subject to $2x_1 + x_2 \geq 4, x_1 + 2x_2 \geq 4$

2. (a) Consider the primal and dual problems in our standard form presented in matrix notation. Use only this definition of the dual problem for a primal problem in this form to prove each of the following results. **(15)**

(i) If the functional constraints for the primal problem $\mathbf{Ax} \leq \mathbf{b}$ are changed to $\mathbf{Ax} = \mathbf{b}$, the only resulting change in the dual problem is to *delete* the nonnegativity constraints, $\mathbf{y} \geq \mathbf{0}$.

(ii) If the functional constraints for the primal problem $\mathbf{Ax} \leq \mathbf{b}$ are changed to $\mathbf{Ax} \geq \mathbf{b}$, the only resulting change in the dual problem is that the nonnegativity constraints $\mathbf{y} \geq \mathbf{0}$ are replaced by nonpositivity constraints $\mathbf{y} \leq \mathbf{0}$, where the current dual variables are interpreted as the negative of the original dual variables.

(iii) If the nonnegativity constraints for the primal problem $\mathbf{x} \geq \mathbf{0}$ are deleted, the only resulting change in the dual is to replace the functional constraints $\mathbf{yA} \geq \mathbf{c}$ by $\mathbf{yA} = \mathbf{c}$.

(b) Suppose that a primal problem has a degenerate BF solution as its optimal solution. What does this degeneracy imply about the dual problem? Why? Is the converse also true? **(9 2/3)**

(c) Consider the following LP model **(22)**

Maximize $Z = 5x_1 + 2x_2 + 3x_3$

subject to

$x_1 + 5x_2 + 2x_3 \leq b_1$

$x_1 - 5x_2 - 6x_3 \leq b_2$

$x_1, x_2, x_3 \geq 0$

Contd P/2

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Contd ... Q. No. 2(c)

The following optimal tableau corresponds to specific values of b_1 and b_2.

Basic	x_1	x_2	x_3	x_4	x_5	Solution
Z	0	a	7	d	e	150
x_1	1	b	2	1	0	30
x_5	0	c	–8	–1	1	10

Determine the following:

(i) The right-side values, b_1 and b_2.

(ii) The optimal dual solution.

(iii) The elements *a*, *b*, *c*, *d*, *e*.

3. (a) Visitors parking at Ozark College is limited to five spaces only. Cars making use of this space arrive according to a Poisson distribution at the rate of six cars per hour. Parking time is exponentially distributed with a mean of 30 minutes. Visitors who cannot find an empty space on arrival may temporarily wait inside the lot unit a parked car leaves. That temporary space can hold only three cars. Other cars that cannot park or find a temporary waiting space must go elsewhere. Determine the following: **(26 2/3)**

(i) The probability, p_n, of *n* cars in the system.

(ii) The *effective* arrival rate of cars that actually use the lot.

(iii) The average number of cars in the lot.

(iv) The average time a car waits for a parking space inside the lot.

(v) The average number of *occupied* parking spaces.

(vi) The average utilization of the parking lot.

(b) For *M*/*M*/1 model, derive the probability distribution of the waiting time in the *queue* for a random arrival when the queue discipline is first-come-first served. **(20)**

4. (a) Distinguish between *deterministic* and *probabilistic* dynamic programming problems. **(8)**

(b) What is *continuous time Markov chain*? Explain why the birth-and-death process is a special type continuous time Markov chain. **(8)**

(c) Consider the following two-person, zero-sum game. **(22 2/3)**

	B_1	B_2	B_3
A_1	5	50	50
A_2	1	1	0.1
A_3	10	1	10

Contd P/3

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Contd ... Q. No. 4(c)

(i) Verify that the strategies (1/6, 0, 5/6) for *A* and (49/54, 5/54, 0) for *B* are optimal, and determine the value of the game.

(ii) Show that the optimal value of the game equals $\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij}\, x_i y_j$.

(d) Distinguish between *discrete-event* and *continuous* simulations using suitable examples. **(8)**

SECTION – B

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

5. (a) The Whitt Window Company is a company with only three employees which makes two different kinds of hand-crafted windows: a wood-framed and an aluminum-framed window. They earn $60 profit for each wood-framed window and $30 profit for each aluminum-framed window. Doug makes the wood frames, and can make 6 per day. Linda makes the aluminum frames, and can make 4 per day. Bob forms and cuts the glass, and can make 48 square feet of glass per day. Each wood-framed window uses 6 square feet of glass and each aluminum-framed window uses 8 square feet of glass. The company wishes to determine how many windows of each type to product per day to maximize total profit. **(26)**

(i) Formulate a linear programming model for this problem.

(ii) Use the graphical method to solve this model.

(iii) A new competitor in town has started making wood-framed windows as well. This may force the company to lower the price they charge and so lower the profit made for each wood framed window. How would the optimal solution change (if at all) if the profit per wood-framed window decreases from $60 to $40? From $60 to $20?

(iv) Doug is considering lowering his working hours, which would decrease the number of wood frames he makes per day. How would the optimal solution change if he makes only 5 wood frames per day?

(b) The Primo Insurance Company is introducing two new product lines: special risk insurance and mortgages. The expected profit is $5 per unit on special risk insurance and $2 per unit on mortgages. Management wishes to establish sales quotas for the new product lines to maximize total expected profit. The work requirements are as follows: **(20 2/3)**

Department	Work-Hours per unit		Work-Hours Available
	Special Risk	Mortgage	
Underwriting	3	2	2400
Administration	0	1	800
Claims	2	0	1200

(i) Formulate a linear programming model for this problem.

(ii) Use the graphical method to solve this model.

(iii) Verify the exact value of your optimal solution from part (b) by solving algebraically for the simultaneous solution of the relevant two equations.

Contd P/4

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6. (a) What is a basic solution? What are the properties of a basic solution? **(10)**

(b) What are the differences between geometric interpretation and algebraic interpretation of the way of solving a problem in simplex method? **(18 2/3)**

(c) Describe the following terms: **(18)**

(i) Degeneracy

(ii) Unbounded zone

(iii) Multiple optimal solutions

7. (a) Work through the simplex method (in algebraic form) step by step to solve the following problem. **(20)**

Maximize $Z = x_1 + 2x_2 + 2x_3$

subject to

$5x_1 + 2x_2 + 3x_3 \leq 15$

$x_1 + 4x_2 + 2x_3 \leq 12$

$2x_1 + x_3 \leq 8$

and $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$

(b) Consider the following problem. **(26 2/3)**

Maximize $Z = 2x_1 + 5x_2 + 3x_3$

subject to

$x_1 - 2x_2 + x_3 \geq 20$

$2x_1 + 4x_2 + x_3 = 50$

and $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$

Using the Big M method, construct the complete first simplex tableau for the simplex method and identify the corresponding initial (artificial) BF solution. Also identify the initial entering basic variable and the leaving basic variable.

8. (a) Consider the transportation problem having the following parameter table: **(30)**

		Destination			Supply
		1	2	3	
Source	1	6	3	5	4
	2	4	M	7	3
	3	3	4	3	2
Demand		4	2	3	

(i) Use Vogel's approximation method manually to select the first basic variable for an initial BF solution.

(ii) Use the northwest corner rule manually to construct a complete initial BF solution.

(b) Write down the advantages and limitations of Vogel's approximation method over Russell's approximation method. **(16 2/3)**

L-3/T-1/IPE **Date : 18/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **HUM 277** (Fundamentals of Economics)

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 assumptions of perfect competition. **(5)**

   (b) Explain the short run equilibrium of a firm under perfect competition. **(8)**

   (c) What is meant by the concept of long run? How would you derive a long run average cost (LAC) curve of a firm from its short run average cost curves? **(7)**

   (d) Given the following total revenue (TR) and total cost (TC) functions for a firm **(15)**

   $TR = 5900Q - 10Q^2$

   $TC = 2Q^3 - 4Q^2 + 140Q + 845$

   where Q is the quantity of output.

   (i) Set up the profit function,

   (ii) Find out the quantity which will make the profit maximum,

   (iii) Calculate the maximum profit and verify that it is maximized.

2. (a) Explain the concept of production function. Discuss the various returns to scale of production. **(10)**

   (b) State and prove the application of Euler's theorem in the theory of distribution of production. **(15)**

   (c) Discuss the internal and external economies of scale of production. **(10)**

3. (a) Describe the circular flow of income and expenditure in a two sector economy. **(7)**

   (b) Explain the product method and income method of measuring national income of a country. **(8)**

   (c) Define inflation. Briefly discuss the policies for controlling inflation with reference to the context of Bangladesh. **(10)**

   (d) Calculate national income from the following information: **(10)**

   GNP = Tk. 1,18,500 crore

   Depreciation = Tk. 10,000 crore

   Indirect tax = Tk. 12,000 crore

   Subsidy is 20% of indirect tax.

Contd P/2

HUM 277/IPE

4. (a) Explain the concept of demand function. **(5)**

(b) What are the various factors that affect the demand for a commodity? Discuss them. Also, discuss "movement along the demand curve" and "shift of the demand curve". **(7)**

(c) Define market equilibrium. Explain the price determination process in an economy under competition. **(8)**

(d) From the following demand and supply functions, calculate the equilibrium price and quantity and show the results in a graph. **(15)**

$P = 0.20Q + 10$

$P = -0.40Q + 70$

(i) What will happen to the equilibrium price and quantity if Government imposes a unit tax of Tk. 5 per unit on sellers?

(ii) What will happen if Government gives a subsidy of Tk. 10 per unit on buyers?

(iii) Show graphically the both changes in equilibrium and explain the scenario.

SECTION – B

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

Symbols indicate their usual meaning.

5. (a) What is elasticity of demand? Define different types of elasticity of demand. Explain who will bear the burden of tax when (i) supply curve is perfectly inelastic and (ii) curve is perfectly elastic. **(10)**

(b) Explain the law of diminishing marginal rate of substitution (MRS) between two goods in consumption. **(10)**

(c) Show how a consumer attain equilibrium with the help of an indifference curve and budget line. **(10)**

(d) What is luxury goods? Suppose, in Bangladesh TV made by 'Sony' is considered as normal good and TV made by 'MyOne' is considered as inferior good. Now if the income level of the consumers of Bangladesh increases, what will happen to the demand curve of the TV made by 'Sony' and 'MyOne'? Explain. **(5)**

6. (a) What is income expansion path? Find out individual demand curve of good 'Y' with the help of this 'income expansion path'. **(10)**

(b) How is total effect comprised of income effect and substitution effect? Suppose **X** is a normal good while **Y** is an inferior good. Now show and explain income effect and substitution effect when price of **Y** rises. **(10)**

(c) Show that 'Weak axiom of revealed preference leads to intransitive choice'. **(5)**

Contd P/3

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Contd ... Q. No. 6

(d) Suppose, Donald Trump has the following utility function: **(10)**

$U(X, Y) = 20X + 80Y - X^2 - 2Y^2$

where, X is his consumption of CDs with a price of $1 and Y is his consumption of movie videos, with a rental price of $2. He plans to spend $41 on both forms of entertainment. Determine the number of CDs and movie videos that will maximize Trump's utility. Also find out the maximum utility.

7. (a) Define Isoquant. Find out its slope (MRTS) in association with the budget constraint. **(5)**

(b) Describe the loss minimizing and the shutdown conditions of a firm under perfect competition. **(10)**

(c) Explain both short run and long run equilibrium scenario of a firm under perfect competition. **(10)**

(d) The following are respectively the average revenue (AR) and average cost (AC) functions of a firm: **(10)**

$AR = 1400 - 7.5Q$ and $AC = Q^2 - 6Q + 140 + 750/Q$

Find out profit maximizing level of output and maximum profit.

8. (a) What is kinked demand curve? 'The short run equilibrium of monopolistic market is nothing but the equilibrium of monopoly market. Do you agree? Why or why not? **(10)**

(b) Explain negative externalities. Also explain the solution to overcome it. **(5)**

(c) According to Amartya Sen, 'the process of economic development can be seen as a process of expanding capabilities of people'. Briefly discuss Amartya Sen's view on economic development preceded by evolution of development economics. **(10)**

(d) Critically explain Harrod-Domar growth model. **(10)**

L-3/T-1/IPE **Date : 24/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **ME 223** (Fluid Mechanics and Machinery)

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**.

Make reasonable assumptions in case of any missing data. Symbols have their usual meaning.

1. (a) Explain the followings in details: **(22)**

   (i) Mach number, (ii) Surface tension, (iii) Capillarity, (iv) Stagnation pressure.

   (b) Mexico city, Mexico, has an elevation of 7575 ft. A barometer located there reads 22.8 inch of Mercury. Determine the local atmospheric pressure at that location and express it in **(13)**

   (i) psia, (ii) psig, (iii) kPa, (iv) Meter of water.

2. (a) From the fundamental concept, derive the pressure equation of fluids undergoing an accelerating motion. From this equation, derive the hydrostatic pressure relation. **(20)**

   (b) The pressure of water flowing through a pipe is measured by an arrangement shown in Fig. 2(b). For the values given, calculate the absolute pressure in the pipe at point A, if the flow arrangement is in standard atmosphere. **(15)**

3. (a) Derive the expression of velocity profile for fully developed laminar flow in a circular pipe and then prove that the average velocity of flow is one-half the maximum velocity. **(18)**

   (b) An oil with $\rho = 900$ kg/m^3 and $\nu = 0.0002$ m^2/s flows through an inclined pipe as shown in Fig. 3(b). The pressure and elevation are known at sections 1 and 2, that are 10 m apart. Assuming steady laminar flow, **(17)**

   (i) verify that the flow is up,

   (ii) compute head loss due to friction between 1 and 2, and

   (iii) compute flow rate, average velocity and Reynolds number. Is the flow really laminar?

4. (a) Differentiate Hydraulic Grade Line (HGL) and Energy Grade Line (EGL). **(5)**

   (b) Water flows from the basement to the second floor through the 0.75 inch diameter copper pipe at a rate of Q = 0.0267 cusec (12 gal./min) and exits through a faucet of diameter 0.50 inch as shown in Fig. 4(b). Determine the pressure at point (1) if **(30)**

   (i) all losses are neglected,

   (ii) only major losses are included,

   (iii) all losses are included.

   Also show the pressure distribution along the pipe for cases (i) and (iii), i.e., neglecting all losses and including all losses, respectively.

Contd P/2

ME 223/IPE

SECTION – B

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

5. (a) What is meant by the dynamic action of fluid? With proper inlet and outlet velocity triangles, derive the expressions of force and work done for a jet striking on a single moving curved vane. **(17)**

   (b) A jet of water having a velocity of 40 m/s strikes a series of curved vanes moving with a velocity of 15 m/s. The jet strikes the vanes with an angle of 25° with the direction of motion of vanes. The relative velocity at the exit is 10% reduced of that at inlet. If the absolute velocity of water at exit is normal to the motion of vanes, find the vane angles at inlet and outlet, and the efficiency. Also find the net force on the vane exerted by water along the normal direction of motion of blade. **(18)**

6. (a) Using the velocity triangles for the flow of water through Pelton wheel, show that the hydraulic efficiency of the wheel is $2u(v - u)(1 + k\cos\phi)/v^2$. Also show the condition for maximum efficiency. The symbols have their usual meanings. **(17)**

   (b) A Pelton wheel is required to develop 10.0 MW under a head of 300 m. Taking coefficient of jet velocity as 0.98, speed ratio as 0.45 and jet ratio as 12, determine, (i) the number of jets, (ii) the mean diameter of the wheel, (iii) the quantity of water to be supplied and (iv) the diameter of the jet. Use the overall efficiency as 85% and the speed of the wheel as 550 rpm. **(18)**

7. (a) Differentiate between Francis turbine and Kaplan turbine. **(7)**

   (b) What is an impeller? Give the details on different types of centrifugal pump impeller with necessary schematics. **(10)**

   (c) Discuss the different heads and efficiencies developed in centrifugal pump. **(10)**

   (d) Draw and explain the characteristics curves for a centrifugal pump. **(8)**

8. (a) Draw the ideal indicator diagram of a single acting reciprocating pump and explain. **(7)**

   (b) A single acting reciprocating pump has a piston of 100 mm diameter and a stroke of 200 mm. The suction and delivery heads are 4 m and 10 m, respectively. The lengths of the suction and delivery pipes are 6 m and 20 m, respectively. The diameter of both pipes is 80 mm. Speed of the pump is 40 rpm and the friction factor for pipe is 0.03. Find the pressure head in the cylinder at the beginning, middle and end of the suction and delivery strokes. Also find the power required to drive the pump. Take 10.3 m of water as atmospheric pressure. **(20)**

   (c) Explain the working principle of air vessels in reciprocating pump arrangements. **(8)**

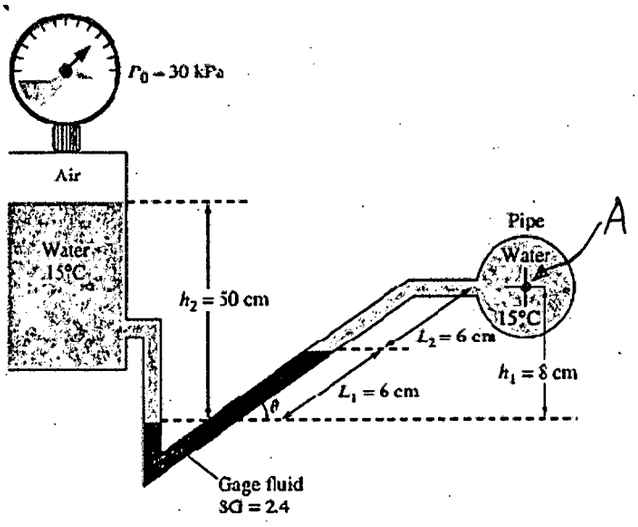

Fig. for Que. No. 2(b)

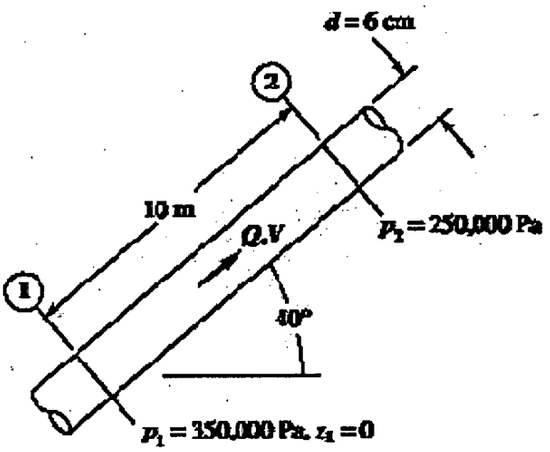

Fig. for Que. No. 3(b)

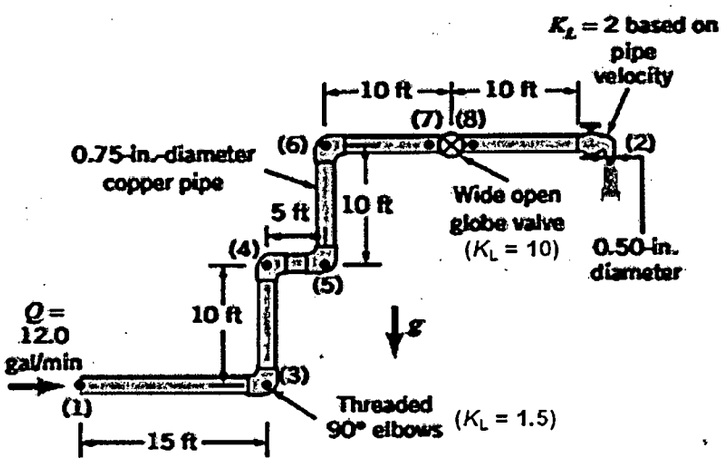

Fig. for Que. No. 4(b)

Table-1

Equivalent roughness values for new commercial pipes*

Material	Roughness, ε ft	mm
Glass, plastic	0 (smooth)	
Concrete	0.003–0.03	0.9–9
Wood stave	0.0016	0.5
Rubber, smoothed	0.000033	0.01
Copper or brass tubing	0.000005	0.0015
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Stainless steel	0.000007	0.002
Commercial steel	0.00015	0.045

* The uncertainty in these values can be as much as ±60 percent.

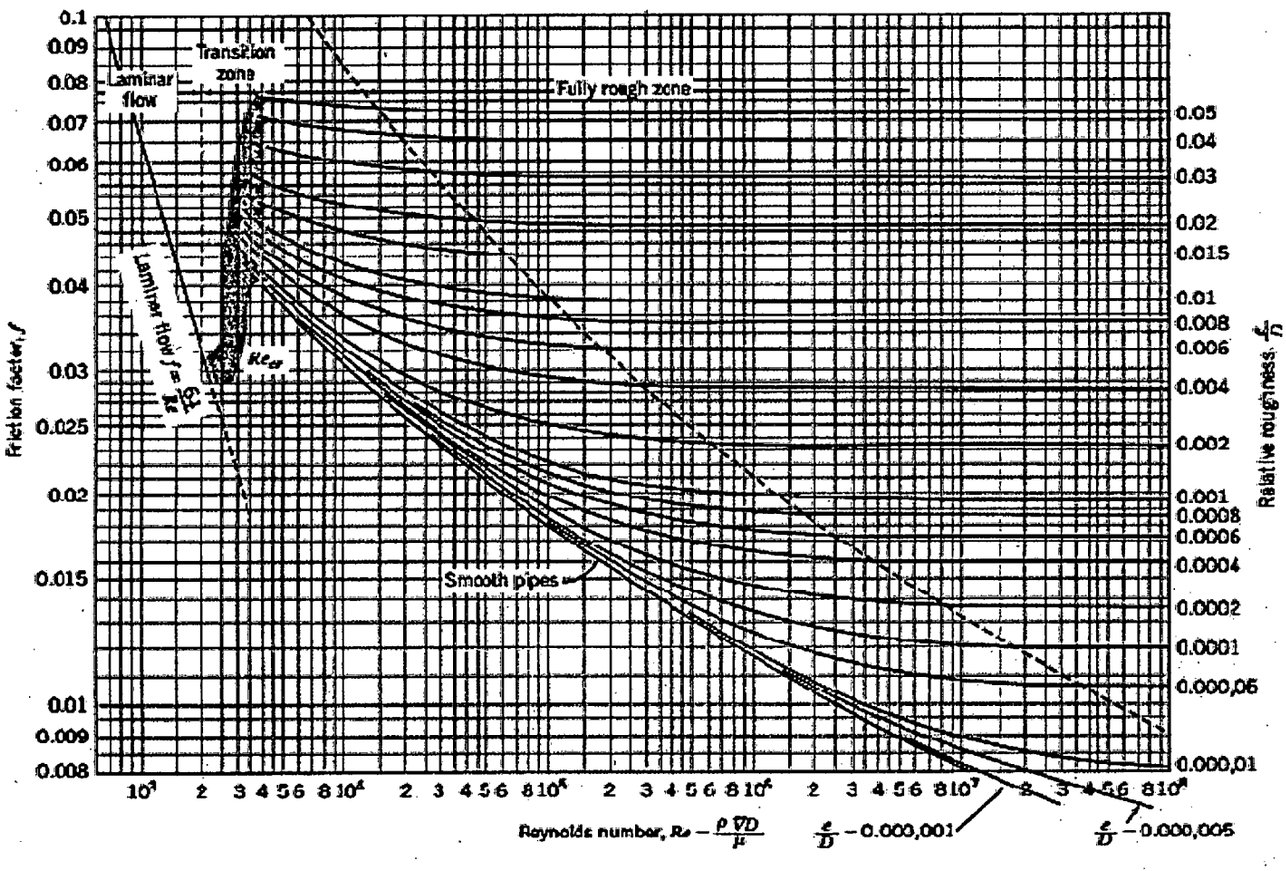

Chart-1: Moody Chart

L-3/T-1/IPE **Date : 29/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **IPE 305** (Manufacturing Process 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**.

1. (a) What is turning operation? Draw the schematic diagrams of the following turning operations along with direction of motion. **(15)**

   (i) Threading
   (ii) Knurling
   (iii) Facing
   (iv) Boring
   (v) Face grooving
   (vi) Cutting off

   (b) What is the difference between contour and form turning? **(5)**

   (c) What is the basic difference between horizontal milling machine and vertical milling machine? Draw a horizontal milling machine and show direction of motion of its different parts. **(15)**

2. (a) Write down the standard marking system for identifying grinding wheels for Aluminum-Oxide and Silicon-Carbide Bonded Abrasives. **(8)**

   (b) What is grinding process? How can grinding process be classified? **(7)**

   (c) Draw the schematic diagrams of following grinding operations along with description. **(16)**

   (i) Surface grinding
   (ii) Cylindrical grinding
   (iii) Internal grinding
   (iv) Centerless grinding

   (d) What is quick return mechanism? Why is it necessary in shaper machine? Explain. **(4)**

3. (a) How can you identify right and left hand single point cutting tool? **(5)**

   (b) Draw a single cutting tool in 3-dimensional view and show the following angles: **(10)**

   (i) Rake angles
   (ii) Clearance angles
   (iii) Cutting edge angles

   (c) Draw the master line (Orthogonal Rake System) and identify all the angles in the diagram. **(20)**

Contd P/2

IPE 305

4. (a) Prove that, **(15)**

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

   (ii) $\tan \gamma_o = \tan \gamma_x \sin \varphi + \tan \gamma_y \cos \varphi$

   (iii) $\tan \gamma_m = \sqrt{\tan^2 \gamma_o + \tan^2 \lambda}$

   (b) During chip formation, show that deformation criteria, $e = 0°$ during pure tension, $e = 30°$ for shear and $e = 60°$ pure compression. **(12)**

   (c) Name and describe the several important variables that affect the tool life in machining? **(8)**

SECTION – B

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

5. (a) With the help of neat sketches, explain the working principles of Abrasive Jet Machining (AJM). List the advantages and disadvantages of AJM. **(15)**

   (b) What are the functions of an electrolyte? What factors need to be considered while selecting it? Discuss the advantages and limitations of some electrolytes. **(12)**

   (c) Explain the need for the use of unconventional machining processes compared to the conventional ones. **(8)**

6. (a) With the help of suitable diagrams discuss the following plastic processing operations: **(20)**

   (i) Lamination

   (ii) Thermoforming

   (iii) Compression Molding

   (iv) Transfer Molding

   (b) Draw schematic diagram of electrochemical machining process. Briefly explain the principle of operation of the process. **(10)**

   (c) Briefly discuss the Press Parameters. **(5)**

7. (a) Describe Injection Molding defects with necessary sketches. **(20)**

   (b) List the functions and necessary characteristics of dielectric fluid in Electrodischarge Machining process. **(8)**

   (c) With the help of suitable sketch, explain Electron Beam Machining process. **(7)**

8. (a) Write details about cutting tools for drilling operations. Draw figures of the tools to identify them. Name the cutting tool bits for drilling operations. **(15)**

   (b) Draw the nomenclature and geometry of drilling tool bit. Explain each of the nomenclatures. **(20)**

L-3/T-1/IPE **Date : 04/02/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **IPE 301** (Measurement, Instrumentation and 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) All sensors and transducers but all transducers are not sensors– justify this statement. **(5)**

(b) Describe the working principle of an LVDT with necessary figure(s). **(10)**

(c) Contrast the resistance change produced by a 150 μm/m strain in a metal strain gauge with gauge factor = 2.13 with a semiconductor strain gauge with gauge factor = –151. Nominal resistance in both cases is 120 Ω. **(10)**

(d) Figure 1(d) shows a capacitive displacement sensor designed to monitor small changes in work-piece position. The two metal cylinders are separated by a plastic sheath of thickness, d = 1.0 mm and dielectric constant of 2.5. If the radius, r is 2.5 cm, find the sensitivity in pF/m as the upper cylinder slides in and out of the lower cylinder. What is the range of capacity if h varies from 1.0 to 2.0 cm? **(10)**

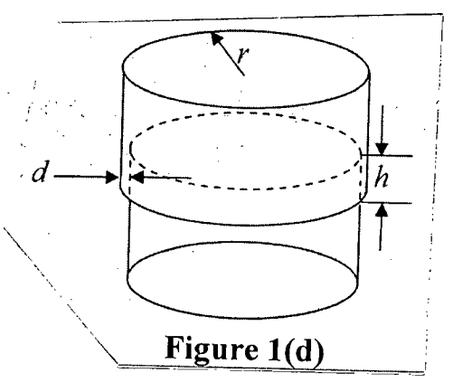

Figure 1(d)

2. (a)The main requirement of a measurement system is "fitness for purpose"– explain with example. **(5)**

(b) Differentiate process control system and servo-control system with suitable examples. **(10)**

(c) A controller output can be expressed as the following: **(10)**

$$p = \begin{cases} 0\% \text{ when } e \le 0 \\ 100\% \text{ when } e > 0 \end{cases}$$

where p = controller output; e = error.

What type of controller is that? Justify your answer.

Contd P/2

IPE 301

Contd... Q. No. 2

(d) An ADC that will encode pressure data is required. The input signal is 666.6 mV/psi. **(10)**

(i) If a resolution of 0.5 psi is required, find the number of bits necessary for the ADC. The reference is 10.0 V.

(ii) Find the maximum measurable pressure.

3. (a) Explain hysteresis error of instrumentation systems with example. **(5)**

(b) Convert 3.07_8 to its equivalent decimal and justify your answer by converting the obtained decimal to its equivalent octal. **(10)**

(c) A Chromel-Constantan thermocouple has a cold junction at 20°C and is to be used for the measurement of temperatures between 0°C and 300°C. **(10)**

Required Data: (0°C, e.m.f. 0.000 mV; 20°C, e.m.f. 1.192 mV; 200°C, e.m.f. 13.419 mV; 300°C, e.m.f. 21.036 mV.)

(i) What will be the thermocouple e.m.f when the hot junction is at 200°C?

(ii) What will be the non-linearity error at 200°C, as a percentage of the full-scale reading, if a linear relationship is assumed over the full range?

(d) Suppose the error shown in Figure 3(d) is applied to a PID controller with $K_P = 6$, $T_D = 0.8$ s and $T_I = 12$ s. The controller is set initially at 50%. Draw a graph of the resulting controller output. Show all calculations. **(10)**

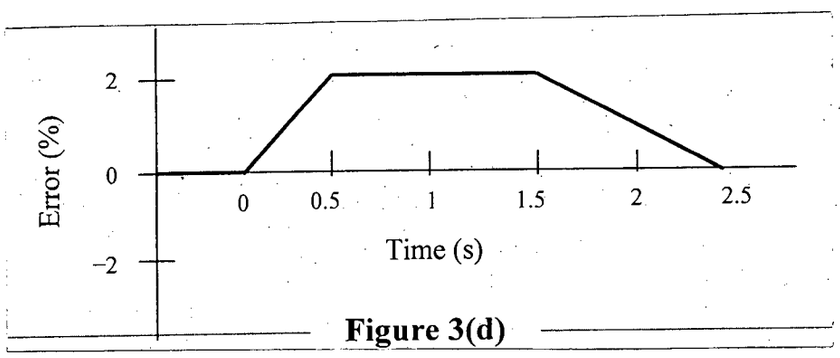

Figure 3(d)

4. (a) Why is Laplace transform used in determining how the output varies with time for elements used in control systems? **(5)**

(b) An open-loop system consists of six elements. There are three elements in series having gains of 2, 5 and 10. The other three elements are in parallel having gains of 2, 4, and 6. What is the overall gain of the system? **(10)**

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(c) The input x and output y of a system are described by the differential equation: **(10)**

$$\frac{dy}{dt} + 2y = x$$

(i) Determine how the output will vary with time when there is an input which starts at zero time and then increases at the constant rate of 6 units/s. The initial output is zero.

(ii) Determine the time constant, the delay time, and the rise time.

(d) A system has output x and input y. Output varies with time t and input y is given by 5 unit step. The system is described by **(10)**

$$5\frac{d^2x}{dt^2} + 20\frac{dx}{dt} + 12x = 13y.$$

Initially the input and output are zero.

(i) What is the state of damping of the system?

(ii) What is the damped angular frequency?

(iii) Express the system output as a function of time.

SECTION-B

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

5. (a) What is the relationship between sensitivity and range? **(8)**

(b) How the error in a quantity dependent on several other quantities can be determined by the method of Binomial approximations due to errors in individual quantities? **(12)**

(c) Discuss the mechanism of an autocollimator. **(5)**

(d) Explain Taylor's principle and its significance with necessary figure. **(10)**

6. (a) Discuss the terms "interchangeability" and "selective assembly". **(5)**

(b) Differentiate unilateral and bilateral tolerances. **(8)**

(c) What are the essential considerations in selection of materials for gauges? **(12)**

(d) Define the following terms: **(10)**

(i) Selective Fit

(ii) Push Fit

(iii) Driving Fit

(iv) Pressed Fit

(v) Shrinkage Fit

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7. (a) Explain why it is preferred not to use a sine bar for generating angles larger than 45° if high accuracy is demanded. **(5)**

(b) Describe the constant chord method of gear tooth measurement. **(10)**

(c) Describe a gear-tooth vernier caliper and explain how this is used for checking gears. **(10)**

(d) Discuss the two wire method of measuring the effective diameter of a screw thread. **(10)**

8. (a) Briefly describe the components of a PLC. **(10)**

(b) Construct a logic network diagram for exclusive OR gate using AND, OR and NOT gates. **(10)**

(c) An emergency stop system is to be designed for a certain automatic production machine. A single "start" button is used to turn on the power to the machine at the beginning of the day. In addition, there are three "stop" buttons located at different locations around the machine, any one of which can be pressed to immediately turn off power to the machine. **(15)**

(i) Write the truth table for this system.

(ii) Write the Boolean logic expression for the system.

(iii) Construct the logic network diagram for the system.

(iv) Construct the ladder logic diagram for the system.

Table: *Laplace* functions and their corresponding time functions

Time Functions $f(t)$	*Laplace* Functions $F(s)$
e^{-at}, exponential decay	$\frac{1}{s+a}$
$1 - e^{-at}$, exponential growth	$\frac{a}{s(s+a)}$
te^{-at}	$\frac{1}{(s+a)^2}$
$t - \frac{1-e^{-at}}{a}$	$\frac{a}{s^2(s+a)}$
$e^{-at} - e^{-bt}$	$\frac{b-a}{(s+a)(s+b)}$
$(1-at)e^{-at}$	$\frac{s}{(s+a)^2}$
$1 - \frac{b}{b-a}e^{-at} + \frac{a}{b-a}e^{-bt}$	$\frac{ab}{s(s+a)(s+b)}$
$\frac{e^{-at}}{(b-a)(c-a)} + \frac{e^{-bt}}{(c-a)(a-b)} + \frac{e^{-ct}}{(a-c)(b-c)}$	$\frac{1}{(s+a)(s+b)(s+c)}$
$\sin \omega t$, a sine wave	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$, a cosine wave	$\frac{s}{s^2+\omega^2}$
$e^{-at} \sin \omega t$, a damped sine wave	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at} \cos \omega t$, a damped cosine wave	$\frac{s+a}{(s+a)^2+\omega^2}$
$\frac{\omega}{\sqrt{1-\zeta^2}} e^{-\zeta\omega t} \sin \omega\sqrt{1-\zeta^2}\, t$	$\frac{\omega^2}{s^2+2\zeta\omega s+\omega^2}$
$1 - \frac{1}{\sqrt{1-\zeta^2}} e^{-\zeta\omega t} \sin\left(\omega\sqrt{1-\zeta^2}\, t + \phi\right),\ \cos\phi = \zeta$	$\frac{\omega^2}{s(s^2+2\zeta\omega s+\omega^2)}$