BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **IPE 105** (Principles of Cost and Management Accounting)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Assume reasonable values for missing data (if any).

SECTION – A

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

1. (a) Hallas Company manufactures a fast-bonding glue in its Northwest plant. The company normally produces and sells 40,000 gallons of the glue each month. This glue, which is known as MJ-7, is used in the wood industry to manufacture plywood. The selling price of MJ-7 is $35 per gallon, variable costs are $21 per gallon, fixed manufacturing overhead costs in the plant total $230,000 per month, and the fixed selling costs total $310,000 per month.

   Strikes in the mills that purchase the bulk of the MJ-7 glue have caused Hallas Company's sales to temporarily drop to only 11,000 gallons per month. Hallas Company's management estimates that the strikes will last for two months, after which sales of MJ-7 should return to normal. Due to the current low level of sales, Hallas Company's management is thinking about closing down the Northwest plant during the strike.

   If Hallas Company dos close down the Northwest plant, fixed manufacturing overhead costs can be reduced by $60,000 per month and fixed selling costs can be reduced by 10%. Start-up costs at the end of the shutdown period would total $14,000. Because Hallas Company uses Lean Production methods, no inventories are on hand.

   Assuming that the strikes continue for two months, would you recommend that Hallas Company close the Northwest plant? Explain. Show computations to support your answer. **(25)**

   (b) Distinguish top-down approach from bottom-up approach to budget preparation with suitable diagrams. **(10)**

2. (a) What is a balanced scorecard approach to performance measurement of an organization? Explain it. **(15)**

   (b) Tami Tyler opened Tami's Creations, Inc., a small manufacturing company, at the beginning of the year. Getting the company its first quarter of operations placed a considerable strain on Ms. Tyler's personal finances. The following income statement for the first quarter was prepared by a friend who has just completed a course in managerial accounting at State University. **(20)**

Contd P/2

IPE 105

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

TAMI'S CREATIONS, INC.
Income Statement
For the Quarter Ended March 31

Sales (28,000 units)		$1,120,000
Less variable expenses:		
Variable cost of goods sold	$462,000	
Variable selling and administrative	168,000	630,000
Contribution margin		490,000
Less fixed expenses:		
Fixed manufacturing overhead	300,000	
Fixed selling and administrative	200,000	500,000
Net operating loss		$ (10,000)

*Consists of direct materials, direct labor, and variable manufacturing overhead.

Ms. Tyler is discouraged over the loss shown for the quarter, particularly since she had planned to use the statement as support for a bank loan. Another friend, a CPA, insists that the company should be using absorption costing rather than variable costing, and argues that if absorption costing had been used the company would probably have reported at least some profit for the quarter.

At this point, Ms. Tyler is manufacturing only one product, a swimsuit. Production and cost data relating to the swimsuit for the first quarter follow:

Units produced	30,000
Units sold	28,000
Variable costs per unit:	
Direct materials	$3.50
Direct labor	$12.00
Variable manufacturing overhead	$1.00
Variable selling and administrative	$6.00

Evaluate the following:

i. The unit product cost under absorption costing

ii. Reconcile the variable and absorption costing net operating income (loss) figures.

3. (a) Thermal Rising, Inc., makes paragliders for sale through specialty sporting goods stores. The company has a standard paraglider model, but also makes custom-designed paragliders. Management has designed an activity-based costing system with the following activity cost pools and activity rates: **(20)**

Activity Cost Pool	Activity Rate
Manufacturing volume	$26 per direct labor-hour
Order processing	$284 per order
Custom design processing	$186 per custom design
Customer service	$379 per customer

Contd P/3

IPE 105

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

Management would like an analysis of the profitability of a particular customer, Big Sky Outfitters, which has ordered the following products over the last 12 months.

	Standard Model	Custom Design
Number of gliders	20	3
Number of orders	1	3
Number of custom designs	0	3
Direct labor-hours per glider	26.35	28.00
Selling price per glider	$1,850	$2,400
Direct materials cost per glider	$564	$634

The company direct labor rate is $19.50 per hour.

Required:

Using the company's activity-based costing system, compute the profitability of each of the two products ordered by Big Sky Outfitters and the overall profitability of this customer.

(b) Xavier Company produces a single product. Variable manufacturing overhead is applied to products on the basis of direct labor-hours. The standard costs for one unit of product are as follows:

Direct material: 6 ounces at $0.50 per ounce	$3
Direct labor: 1.8 hours at $10 per hour	18
Variable manufacturing overhead: 1.8 hours at $5 per hour	9
Total standard variable cost per unit	$30

During June, 2000 units were produced. The costs associated with June's operations were as follow:

Material purchased: 18,000 ounces at $0.60 per ounce	$10,800
Material used in production: 14,000 ounces	—
Direct labor: 4,000 hours at $9.75 per hour	$39,000
Variable manufacturing overhead costs incurred	$20,800

Required: **(15)**

Compute the direct materials, direct labor and variable manufacturing overhead variances.

4. (a) Mynor Company manufactures and sells a product that has seasonal variations in demand, with peak sales coming in the third quarter. The following information concerns operations for Year 2–the coming year–and for the first two quarters of Year 3. **(25)**

Contd P/4

IPE 105

Contd ... Q. No. 4(a)

- The company's single product sells for $8 per unit. Budgeted sales in units for the next six quarters are as follows:

	Year 2 Quarter				Year 3 Quarter	
	1	2	3	4	1	2
Budgeted sales in units ...	40,000	60,000	100,000	50,000	70,000	80,000

- Sales are collected in the following pattern: 75% in the quarter the sales are made, and the remaining 25% in the following quarter. On January 1, Year 2, the company's balance sheet showed $65,000 in accounts receivable, all of which will be collected in the first quarter of the year. Bad debts are negligible and can be ignored.
- The company desires an ending inventory of finished units on hand at the end of each quarter equal to 30% of the budgeted sales for the next quarter. On December 31, Year 1, the company had 12,000 units on hand.
- Five pounds of raw materials are required to complete one unit of product. The company requires an ending inventory of raw materials on hand at the end of each quarter equal to 10% of the production needs of the following quarter. On December 31, Year 1, the company had 23,000 pounds of raw materials on hand
- The raw material costs $0.80 per pound. Purchases of raw material are paid for in the following pattern: 60% paid in the quarter the purchases are made, and the remaining 40% paid in the following quarter. On January 1, Year 2, the company's balance sheet showed $81,500 in accounts payable for raw material purchases, all of which will be paid for in the first quarter of the year.

Required:

Prepare the following budgets and schedules for the year, showing both quarterly and total figures:

i. A sales budget and a schedule of expected cash collections.

ii. A production budget

iii. A direct materials budget and a schedule of expected cash payments for purchases of materials.

(b) Banner Company produces three products: A, B, and C. The selling price, variable costs, and contribution margin for one unit of each product follow:

Contd P/5

IPE 105

Contd ... Q. No. 4(b)

	Product		
	A	B	C
Selling price	$60	$90	$80
Variable costs:			
Direct materials	27	14	40
Direct labor	12	32	16
Variable manufacturing overhead	3	8	4
Total variable cost	42	54	60
Contribution margin	$18	$36	$20
Contribution margin ratio	30%	40%	25%

Due to a strike in the plant of one of its competitors, demand for the company's products far exceeds its capacity to produce Management is trying to determine which product(s) to concentrate on next week in filling its backlog of orders. The direct labor rate is $8 per hour, and only 3,000 hours of labor time are available each week.

Required: **(10)**

i. Compute the amount of contribution margin that will be obtained per hour of labor time spent on each product.

ii. Which orders would you recommend that the company work on next week – the orders for product A, product B, or product C? Show computations.

SECTION – B

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

5. Smithson Company uses a job-order costing system and has two manufacturing departments – Molding and Fabrication. The company provided the following estimates at the beginning of the year:

	Molding	Fabrication
Machine-hours	20,000	30,000
Fixed manufacturing overhead costs	$8,00,000	$3,00,000
Variable manufacturing overhead per machine-hr	$5.00	$5.00

Contd P/6

IPE 105

Contd ... Q. No. 5

During the year, the company had no beginning or ending inventories and it started, completed, and sold only two jobs – Job D-75 and Job C-100. It provided the following information related to those two jobs:

Job D-75	Molding	Fabrication
Direct materials cost	$3,75,000	$3,25,000
Direct labor cost	$2,00,000	$1,60,000
Machine-hours	15,000	5,000

Job C-100	Molding	Fabrication
Direct materials cost	$3,05,000	$2,50,000
Direct labor cost	$1,75,000	$2,25,000
Machine-hours	5,000	25,000

Smithson had no overapplied or underapplied manufacturing overhead during the year. **(35)**

Required:

(a) Assume Smithson uses a plantwide overhead rate based on machine-hours.

i. Compute the predetermined plantwide overhead rate.

ii. Compute the total manufacturing costs assigned to Job D-75 and Job C-100.

iii. If Smithson establishes bid prices that are 150% of total manufacturing costs, what bid price would it have establish for Job D-75 and Job C-100?

iv. What is Smithson's cost of goods sold for the year?

(b) Assume Smithson uses departmental overhead rates based on machine-hours.

i. Compute the predetermined departmental overhead rates.

ii. Compute the total manufacturing costs assigned to Job D-75 and Job C-100.

iii. If Smithson establishes bid prices that are 150% of total manufacturing costs, what bid price would it have establish for Job D-75 and Job C-100?

iv. What is Smithson's cost of goods sold for the year?

(c) What managerial insights are revealed by the computations that you performed in this problem? (Hint: Do the cost of goods sold amounts that you computed in requirements (a) and (b) differ from one another? Do the bid prices that you computed in requirements (a) and (b) differ from one another? Why?)

6. Bohemian Links Inc. produces sausages in three production departments – Mixing, Casing and Curing, and Packaging. In the Mixing Department, meats are prepared and ground and then mixed with spices. The spiced meat mixture is then transferred to the Casing and Curing Department, where the mixture is force-fed into casings and then hung and cured in climate-controlled smoking chambers. In the Packaging Department, the cured sausages are sorted, packed, and labeled. The company uses the weighted-average method in its process costing system. Data for April for the Casing and Curing Department follow: **(35)**

Contd P/7

IPE 105

Contd ... Q. No. 6

		Percent Completed		
	Units	Mixing	Material	Conversion
Work in process inventory, April 1	1	100%	60%	50%
Work in process inventory, April 30	1	100%	20%	10%

	Mixing	Material	Conversion
Work in process inventory, April 1	$1,640	$26	$105
Cost added during April	$94,740	$8,402	$61,197

Mixing cost represents the costs of the spiced meat mixture transferred in form the Mixing Department. The spiced meat mixture is processed in the Casing and Curing Department in batches; each unit in the above table is a batch, and one batch of spiced meat mixture produces a set amount of sausages that are passed on to the Packaging Department. During April, 60 batches (i.e., units) were completed and transferred to the Packaging Department.

Required:

i. Determine the equivalent units for April for mixing, materials, and conversion. Do not round off your computations.

ii. Compute the costs per equivalent unit for April for mixing, materials and conversion.

iii. Determine the total cost of ending work in process inventory and the total cost of units transferred to the Packaging Department in April.

iv. Prepare a cost reconciliation report for the Casing and Curing Department for April.

7. Memofax, Inc., produces memory enhancement kits for fax machines. Sales have been very erratic, with some months showing a profit and some months showing a loss. The company's contribution format income statement for the most recent month is given below:

Sales (13,500 units at $20 per unit)	$ 2,70,000
Variable expenses	1,89,000
Fixed expenses	90,000

Required: **(35)**

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

(b) The sales manager feels that an $8,000 increase in the monthly advertising budget, combined with an intensified effort by the sales staff, will result in a $70,000 increase in monthly sales. If the sales manager is right, what will be the effect on the company's monthly net operating income or loss? (Use the incremental approach in preparing your answer.)

(c) Refer to the original data. The president is convinced that a 10% reduction in the selling price, combined with an increase of $35,000 in the monthly advertising budget, will double unit sales. What will the new contribution format income statement look like if these changes are adopted?

Contd P/8

IPE 105

Contd ... Q. No. 7

(d) Refer to the original data. The company's advertising agency thinks that a new package would help sales. The new package being proposed would increase packaging costs by $0.60 per unit. Assuming no other changes, how many units would have to be sold each month to earn a profit of $4,500?

(e) Refer to the original data. By automating, the company could slash its variable expense in half. However, fixed costs would increase by $118,000 per month

i. Compute the new CM ratio and the new break-even point in both units and dollars.

ii. Assume that the company expects to sell 20,000 units next month. Prepare two contribution format income statements, one assuming that operations are not automated and one assuming that they are.

iii. Would you recommend that the company automate its operations? Explain.

8. (a) Nature's Way, Inc., keeps one of its production facilities busy making a perfume called Essence do la Vahce. The perfume goes through two processing departments: Blending and Bottling. The following incomplete Work in Process account is provided for the Blending Department for March: **(27)**

March 1 balance	32,800	Completed and transferred
Materials	147,600	to Bottling (760,000 ounces)?
Direct labor	73,200	
Overhead	481,000	
March 31 balance	?	

The $32,800 beginning inventory in the Blending Department consisted of the following elements: materials, $8,000; direct labor, $4,000; and overhead applied, $20,800. Costs incurred during March in the Bottling Department were: materials used, $45,000; direct labor, $17,000; and overhead cost applied to production, $108,000.

Required:

(I) Prepare journal entries to record the costs incurred in both the Blending Department and Bottling Department during March. Key your entries to items (i) through (vii) below:

i. Raw materials were issued for use in production.

ii. Direct labor cost were incurred.

iii. Manufacturing overhead costs for the entire factory were incurred, $596,000. (Credit Accounts Payable and use a single Manufacturing Overhead control account for the entire factory.)

iv. Manufacturing overhead was applied to production using a predetermined overhead rate.

Contd P/9

IPE 105

Contd ... Q. No. 8(a)(I)

v. Units that were complete with respect to processing in the Blending Department were transferred to the Bottling Department, $722,000.

vi. Units that were complete with respect to processing in the Bottling Department were transferred to Finished Goods, $920,000.

vii. Completed units were sold on account for $1,400,000. The cost of goods sold was $890,000.

(II) Post the journal entries from (I) above to T-accounts. The following account balances existed at the beginning of March. (The beginning balance in the Blending Department's Work in Process account is given above.)

Raw Materials	$198,600
Work in Process—Bottling Department	$49,000
Finished Goods	$20,000

After posting the entries to the T-accounts, find the ending balances in the inventory accounts and the manufacturing overhead account.

(b) Calculate cost of goods manufactured, cost of goods sold and net operating income based on the following information: **(8)**

R/M inventory (start)	$ 40000
R/M inventory (end)	50000
R/M purchased	400000
Direct Labor cost	150000
Manufacturing O/H	800000
WIP inventory (start)	200000
WIP inventory (end)	180000
F/G inventory (start)	250000
F/G inventory (end)	300000
Sales	1800000
Selling and administrative expense	190000

L-1/T-1/IPE Date : 31/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **HUM 211** (Sociology)

Full Marks: 140 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) 'Sociological imagination is an empowering tool, allows us to look beyond our limit experiences'– Explain this statement with suitable examples. **(10)**

   (b) 'The most interesting aspect of human society is the hidden meanings behind everyday routine interactions'– Explain this statement highlighting interactionist perspective of sociology. **(13 1/3)**

2. (a) What is social mobility? Discuss horizontal mobility and vertical mobility with examples. **(10)**

   (b) What is social stratification? Explain different systems of social stratification in the context of Bangladesh. **(13 1/3)**

3. (a) Illustrate the features of knowledge economy. **(10)**

   (b) Critically explain the social significance of fordism and post-fordism production system. **(13 1/3)**

4. Write short notes on any three of the following: **(23 1/3)**

   (a) Types of social norms.
   (b) Ethnocentrism.
   (c) Social values and social sanctions.
   (d) Subculture and counter culture.

SECTION - B

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

5. (a) What is meant by environment, natural green house and man-made green house? **(9)**

   (b) Discuss the impact of various types of greenhouse gases on society. **(5 1/3)**

   (c) Explain briefly the potential consequence of global warming. **(9)**

Contd P/2

HUM 211

6. (a) Define globalization. Which aspects of globalization do you find advantageous and which ones objectionable? **(8)**

(b) Define demography, crude birth-rate and crude death-rate. Describe the stages of demographic transition theory. **(10)**

(c) What is meant by urbanization, urbanism and over-urbanization? **(5 1/3)**

7. (a) Write down the characteristics of pre-industrial, industrial and post-industrial societies. **(6)**

(b) Define industrialization and deindustrialization. Discuss the effects of deindustrialization on societies. **(10)**

(c) What impacts did the industrial revolution have on societies? **(7 1/3)**

8. Write short notes on any THREE of the following: **(23 1/3)**

(a) Features of capitalism

(b) Sources of social change

(c) Impacts global warming

(d) Growth of cities.

L-1/T-1/IPE **Date: 27/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **PHY 117** (Structure of matter, Electricity and magnetism, and Modern physics)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) State Gauss's law of electrostatics. Derive Coulomb's laws from Gauss's law. **(12)**

   (b) Using Gauss's law, calculate $\vec{E}$ for an infinitely long line of charge (e.g. a wire with negligible diameter) with a constant charge per unit length λ. **(12)**

   (c) An α-particle, approaching the surface of a nucleus of gold, is a distance equal to one nuclear radius (6.9×10^{-15} m) away from that surface. What are the forces on the α-particle and its acceleration at the point? The mass of the α-particle which may be treated here at a point, is 6.7×10^{-27} kg. **(11)**

2. (a) State and explain Biot-Savart law and Ampere's law. **(12)**

   (b) Applying Biot-Savart law, derive an expression for magnetic field at a distance, a, due to an infinitely long straight wire carrying a current I. **(15)**

   (c) Two long wires a distance, d, apart carry equal antiparallel currents, i. Show that magnetic induction, B, at any point at a distance, R, (from the perpendicular bisector of distance between wires) which is equidistant from the wires is given by **(8)**

$$B = \frac{2\mu_0 id}{\pi\left(4R^2 + d^2\right)}$$

3. (a) State and explain Faraday's law of elecromagnetic induction. **(7)**

   (b) An air-core toroidal solenoid with cross-section area, A and mean radius, r, is closely wound with N turns of wire. Determine its self-inductance, L. Assume that magnetic induction, B, is uniform across the cross section. **(10)**

   (c) A long coaxial cable consists of two concentric cylinders with radii, a, and b. Its central conductor carries a steady current, i, the outer conductor providing the return path. (i) Calculate the energy stored in the magnetic field for length, L, of such a cable. (ii) What is the inductance of a length, L, of coaxial cable? **(18)**

4. (a) Demonstrate the splitting of energy levels with the decrease of interatomic distance during the formation of bands in a solid. How the band structure of an intrinsic semiconductor is affected due to n-type and p-type impurity doping? **(12)**

Contd P/2

PHY 117

Contd... Q. No. 4

(b) Derive Bragg's law of X-ray diffraction. Write down the advantages of using X-rays for crystal structure analysis. Why visible light cannot be chosen for crystal structure analysis? **(18)**

(c) X-rays beams of wavelength 1.57 Å are reflected from the 2nd (132) plane of a crystal. Consider the interplanar spacing between two (132) parallel planes is 4.05 Å. Determine the angle through which X-rays are reflected. **(5)**

SECTION – B

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

5. (a) What are crystalline and non-crystalline solids. Distinguish between edge and screw dislocations in crystals. **(12)**

(b) Define Miller indices and describe the process of finding the Miller indices of a crystal plane. Find the relation between Miller indices (hkl) and inter-planar distance (d_{hkl}) for a crystal system having mutually perpendicular crystallographic axes. **(18)**

(c) The lattice constants of a tetragonal crystal are a = 1.54 Å and c = 2.67 Å. Find the inter-planar distance between the (112) planes in the crystal. **(05)**

6. (a) Write down the characteristics of Van der Waals bond and hydrogen bond in solids. Prove that Van der Waals force of attraction between very closely spaced polar and non-polar molecules is proportional to r^{-7}; where, r is the distance between the two molecules. **(12)**

(b) Describe sodium chloride (NaCl) structure with a necessary diagram and explain the reason for calling it a face centered cubic (fcc) structure. Why NaCl crystals are brittle? Establish the formula for determination of the packing factor of NaCl structure. How does the packing factor of NaCl differ from that of a standard fcc structure? **(18)**

(c) Magnesium oxide (MgO) crystal shows the NaCl type of structure. Ionic radii of Mg^{2+} and O^{2-} ions are 0.086 nm and 0.126 nm, respectively. Evaluate the packing factor of MgO structure. **(05)**

7. (a) What are the failures of classical physics to explain photo-electric effect? **(07)**

(b) What is Compton effect? Show that the expression for the change in wavelength of a photon undergoing Compton scattering is, **(19)**

$\lambda' - \lambda = \frac{h}{m_O c}(1 - \cos\varphi)$, where the symbols have their usual meaning.

Contd P/3

PHY 117

Contd... Q. No. 7

(c) A photon of 1 MeV collides with a free but stationery electron and scatters off a 90°. What are the energies of the scattered photon and the kinetic energy of the recoil electron? **(09)**

8. (a) Define binding energy of a nucleus. Sketch the graph of binding energy per nucleon. What information can you obtain from this curve? **(12)**

(b) Draw a schematic diagram of nuclear reactor and briefly describe the various components of a nuclear reactor. **(14)**

(c) A city requires on the average 200 MW of electric power per day and this is to be supplied by a nuclear reactor of efficiency 25%. Using U^{238} as a nuclear fuel, calculate the amount of fuel required for one day's operation. Energy released per fission of U^{238} nuclide is 200 MeV. **(09)**

L-1/T-1/IPE **Date : 04/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CHEM 119** (Chemistry-I)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) What are the possible forces operating in the dissolution processes? **(5+12=17)**
Discuss the mechanism of ion-dipole interaction in the dissolution of NaCl in H_2O. Show the energy diagram associated with this dissolution process.
(b) Summarize the concept of "Dynamic equilibrium" that exists in the saturated aqueous system: **(6+12=18)**
Solid + $H_2O \Leftrightarrow$ SS (saturated solution). Apply La Chatelier principle to the above endothermic dissolution equilibrium. Show mathematically that solubility of a saturated solution of a solid in liquid is constant. Narrate the influence of temperature on the above solubility based on Clausius-Clapeyron concept.

2. (a) What is meant by autoionization of water? Write the expression for K_w. Find its value at 25°C. **(7+10=17)**
At 60°C, the value of K_w is 1×10^{-13}. Predict whether the reaction: $2H_2O(l) \Leftrightarrow H_3O^+(aq) + OH^-(aq)$ is exothermic or endothermic. Calculate the $[H^+]$ and $[OH^-]$ in a neutral solution at 60°C.
(b) Illustrate the meaning of the following terms: (i) pOH , (ii) pK, (iii) pK_w . **(6+12=18)**
What do you understand by % dissociation of CH_3COOH?
Calculate the % dissociation of CH_3COOH ($K_a = 1.8 \times 10^{-5}$) in each of the following solution: (i) 1.00 M CH_3COOH, (ii) 0.100 M CH_3COOH.

3. (a) Define the terms: cell voltage and cell potential. Write the cell diagram for a galvanic cell consisting of an Al electrode placed in a 1 M $Al(NO_3)_3$ solution and a Ag electrode placed in a 1 M $AgNO_3$ solution. Sketch the basic features of a galvanic cell with Zn electrode and standard hydrogen electrode (SHE) and thus describe how the standard reduction potential of Zn ($E^\circ_{Zn^{2+}/Zn}$) can be determined. **(5+12=17)**
(b) Write the equations relating ΔG° and K to the standard emf of a cell. Define all the terms in each equation. **(6+12=18)**
Consider the galvanic cell based on the following half-reactions:

$$Zn^{2+} + 2e^- \rightarrow Zn \qquad E^\circ = -0.76V$$
$$Fe^{2+} + 2e^- \rightarrow Fe \qquad E^\circ = -0.44V$$

Contd P/2

CHEM 119

Contd... Q. No. 3 (b)

(i) Determine the overall cell reaction and calculate E°_{cell}.

(ii) Calculate ΔG° and K for the cell reaction at 25°C.

(iii) Calculate E_{cell} at 25°C when $[Zn^{2+}] = 0.10$ M and $[Fe^{2+}] = 1.0 \times 10^{-5}$ M.

4. (a) State phase rule. How it takes the form for a condensed system? Define each term associated with the phase rule. **(5+12=17)**

Sketch and describe the phase diagram of the Pb-Ag alloy system.

(b) State the laws of osmotic pressure. **(6+12=18)**

How desalination of sea water is carried out by reverse osmosis process?

A solution is prepared by dissolving 44.1 g of hemoglobin (Hb) in enough water to make up 1 L in volume. If the osmotic pressure of the solution is found to be 12.6 mmHg at 25°C, calculate the molar mass of Hb.

SECTION - B

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

5. (a) Classify polymer with suitable examples. **(5)**

(b) What are number average molecular weight and weight average molecular weight? Calculate the number average molecular weight and weight average molecular weight from the following table: **(10)**

Vegetables	Number of units, *n*	Weight, M(g)
Onions	2	10
Brinjals	4	20
Cabbages	6	100
Cauliflowers	3	250

(c) How will you synthesis an azo dye? What is the effect of high acidity on the amine or phenol with which the diazonium salt is reacting? Suggest a reason for the use of excess mineral acid in the diazotization process. **(10)**

(d) Define– polar covalent bonding and intramolecular hydrogen bonding with example. Draw the crystal structure of CsCl and write coordination number of Cs^{+}. **(10)**

Contd P/3

CHEM 119

6. (a) Explain Lanthanide contraction. Classify the number of series of transition metal and write them in detail. Why transition metals show high enthalpy of atomization? **(10)**

(b) Explain– why $[Co(H_2O)_6]^{2+}$ complex is pink color? Calculate magnetic moment of Co^{2+} ion. What are homogeneous and heterogeneous catalysis? Give suitable examples. **(10)**

(c) Show the periodic trends for non-metallic character, electronegativity and atomic radii in periodic table. Write some uses of noble gases. **(10)**

(d) Define Lattice energy. Define the factors on which it depends. **(5)**

7. (a) What are the shortcomings of Bohr atomic model? What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition $n = 4$ to $n = 2$ of He^+ transition? **(10)**

(b) Strength of hydrogen bond in H–F is more than in H_2O but still HF is a gas and H_2O is a liquid at room temperature. Explain. **(5)**

(c) What are the characteristics of hybrid orbital? Explain why sigma (σ) bond is stronger than pi (π) bond. **(10)**

(d) What is Compton effect? Compare and contrast between valence bond theory (VBT) and molecular orbital theory (MOT). **(10)**

8. (a) How does molecular orbital theory (MOT) explain the difference in reactivity of N_2 and O_2? How is the solubility of NH_3 in H_2O? **(10)**

(b) Define bond order. What kind of information can be provided by bond order? Show the difference between bonding and antibonding molecular orbitals. **(10)**

(c) Draw orbital picture of acetylene. Predict the geometry (shape, bond angle, lone pairs) of the following molecules/ions using VSEPR theory: **(10)**

(i) $AlCl_3$ (ii) NO_2^- (iii) ICl_3 (iv) HF

(d) Derive an expression for the radius of 1st orbit in the atom. **(5)**

L-1/T-1/IPE **Date : 21/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **MATH 191** (Differential Calculus and Integral Calculus)

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) A function $f(x)$ is defined as follows: **(20 2/3)**

$$f(x)=\begin{cases} 0 & ; \quad -5\le x<-2 \\ -x^2+4 & ; \quad -2\le x\le 2 \\ -x+3 & ; \quad 2<x\le 5 \end{cases}$$

Discuss the continuity and differentiability of the function at $x = 2$ and interpret your answer. Sketch the graph.

(b) Find the n-th derivative of $y=e^{2x}\sin 3x$. **(14)**

(c) Evaluate: $\lim\limits_{x\to 0}\left(x\ln(\sin x)\right)$ **(12)**

2. (a) State Leibnitz's theorem. If $y = \sin(m\sin^{-1}x)$, then show that **(20 2/3)**

$(1-x^2)y_{n+2}-(2n+1)xy_{n+1}+(m^2-n^2)y_n=0$. Also find $y_n(0)$.

(b) Verify Cauchy's mean value theorem for the functions $f(x)=x^2-2x+3$ and $g(x)=x^3-7x^2+26x-5$ in the interval $[-1,1]$. **(16)**

(c) Expand the function $f(x)=\sin x$ in power of $(x-\frac{\pi}{2})$. **(10)**

3. (a) Find the maximum and minimum values of the function $f(x)=x^2\log\left(\frac{1}{x}\right)$. Also find the point of inflection. **(20 2/3)**

(b) If $u=\sqrt{(x^2+y^2+z^2)}$, then show that $\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}=\frac{2}{u}$. **(14)**

(c) Show that the pedal equation of the cardioid $r=a(1+\cos\theta)$ is $r^3=2ap^2$. **(12)**

4. (a) Find the equation of the normal to the curve $2x^2-y^2=14$ that is also parallel to $x+3y=4$. **(15 2/3)**

(b) Prove that the spirals $r^n=a^n\cos n\theta$ and $r^n=b^n\sin n\theta$ intersect orthogonally. **(16)**

(c) Find all the asymptotes of the curve $x^3-2x^2y+xy^2+x^2-xy+2=0$. **(15)**

Contd P/2

MATH 191

SECTION - B

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

5. Perform the following: **(15+15+16 2/3)**

(a) $\int \frac{dx}{x^{3/2}(a+bx)^{5/2}}$, (b) $\int \frac{(3x-2)}{\sqrt{3+2x-4x^2}}dx$, (c) $\int \frac{x^2\,dx}{(x\sin x+\cos x)^2}$.

6. (a) Obtain a reduction formula for $I_n = \int x\cos^n x\,dx$ and hence obtain $\int x\cos^4 x\,dx$. **(17)**

(b) Show that: $\int_0^{\pi} \frac{x^3\cos^4 x\sin^2 x}{\pi^2-3\pi x+3x^2}dx = \frac{\pi^2}{32}$. **(16)**

(c) Evaluate: $\int_0^{\pi/2} \frac{\sin x\cos x}{a^2\sin^2 x+b^2\cos^2 x}dx$ **(13 2/3)**

7. (a) Prove that: $\int_0^{\infty}\left(x+\frac{1}{x}\right)\frac{dx}{1+x^2} = \pi\log 2$. **(17)**

(b) Evaluate: $\int_0^1 \frac{x^2dx}{\sqrt{1-x^4}} \times \int_0^1 \frac{dx}{\sqrt{1+x^4}}$ **(17)**

(c) Find the area enclosed by the following curve $a^2y^2 = a^2x^2 - x^4$. **(12 2/3)**

8. (a) Find the common area between the following curves $r = \cos\theta$ and $r = \sin\theta$. **(12)**

(b) Determine the perimeter of the loop of $3ay^2 = x(x-a)^2$. **(16)**

(c) Find the volume and surface area of the solid generated by revolving the cardioid $r = a(1+\cos\theta)$ about the initial line. **(18 2/3)**
