

Q. No. BT - 501 / 088

**B. Tech./Odd
2016-17/Reg**

2016-17

IMMUNOLOGY

BT - 501

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any seven questions.

10×7

1. Give the full form of GVHD. How complement system works? Name two fluorochrome materials, used in fluorescence microscopy and their mode of action.

1+4+5

2. Give differences between monoclonal and polyclonal antibodies. Name one antibody which can cross placenta. Write schematically how polyclonal anti-sera can be raised.

4+1+5

3. Write short notes on :

(a) Immuno-electron microscopy

(b) Radial Immuno Diffusion.

5+5

4. Describe the interaction between T cell and Antigen presenting cells (APC). What is adjuvant? How antibody diversity is attained through class switching?

4+2+4

5. Write the properties of cytokines. State the origin, target cell and function of any three cytokines.

4+6

P.T.O.

(2)

6. How attenuated and killed organisms can be used as vaccine candidates? What is cross linking? What are the difference between Primary and Secondary immune response?

4+1+5

7. What is the basic concept of blood grouping? Differentiate between RIA and Competitive ELISA. How two antigen can be separated through Immunoprecipitation technique?

3+3+4

8. How DNA vaccine can be designed? What is phagocytosis? How dendritic cell is different from other cells characteristically?

3+2+5

9. How graft rejection can be suppressed? What is the difference between autograft and isograft? Design one experiment to show that graft rejection is an Immunological phenomenon.

3+2+5

Q. No. BT - 502 / 092

B. Tech./Odd
2016-17/Reg

2016-17

**THERMODYNAMICS AND BIOCHEMICAL
REACTION ENGINEERING**

BT - 502

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any five questions.

1. (i) An ideal gas ($C_p = 5 \text{ Kcal/Kmol}^\circ\text{C}$, $C_v = 3 \text{ Kcal/Kmol}^\circ\text{C}$) is changed from 1 atm and 22.4m^3 to 10 atm and 2.24m^3 by the following reversible process :

- (a) Isothermal compression
- (b) Adiabatic compression followed by cooling at constant volume.
- (c) Heating at constant volume followed by cooling at constant pressure.

Draw the path in a P-V diagram and calculate Q, W, ΔU and ΔH of the overall process in each case.

- (ii) A vessel is divided into two compartments and contains 2 mol N_2 gas at 80°C and 40 bar on one side and 3 mol of argon gas at 150°C and 15 bar on the other side. Calculate the change in entropy when the

(2)

partition is removed and the gases are mixed adiabatically and completely. Assume that both the gases are ideal.

(iii) In an adiabatic change for an ideal gas, show that the work done in an adiabatic expansion —

$$W = \frac{P_1 V_1}{\gamma - 1} \left[1 - \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} \right] \quad 8+3+3$$

2. (i) Find the second, third and fourth virial coefficients of van der Waals' equation of state.

(ii) Calculate the pressure of 1.0 kmol of methane occupied a volume of 0.9 m³ in a vessel at a constant temperature of 533 K by using (a) ideal gas equation, (b) van der Waals' equation of state, when $a = 0.4233 \text{ Nm}^4/\text{mol}^2$ and $b = 3.73 \times 10^{-5} \text{ m}^3/\text{mol}$ and (c) Redlich-Kwong equation of state when $P_C = 123.2$ bar and $T_C = 398 \text{ K}$. 5+9

3. (i) What is the significance of acentric factor? Calculate the acentric factor for ethanol. The vapour pressure of methanol can be estimated from the following equation —

$$\log_{10} P_{\text{sat}} = 8.1122 - \frac{1592.864}{t + 226.184}$$

(ii) A gas obeys the equation of state $P(V-b) = RT$. For this gas $b = 0.0391 \text{ litre/mol}$. Calculate the fugacity and fugacity coefficient for the gas at 1000°C and 1000 atm. (2+7)+5

(3)

4. (i) Define Joule-Thomson co-efficient " μ ". Express μ in terms of C_p and compressibility factor Z in the following form :

$$\mu = \frac{RT^2}{PC_p} \left(\frac{\partial Z}{\partial T} \right)_p, \text{ where, } PV = ZRT$$

(ii) Derive the following equations : on set (v)

$$(a) \left(\frac{\partial T}{\partial V} \right)_S = \frac{\beta T}{C_V \kappa}$$

$$(b) \left(\frac{\partial T}{\partial P} \right)_H = \frac{V}{C_P} (\beta T - 1) \quad \text{where, } \kappa = \text{isothermal compressibility.}$$

5. (i) Define substrate inhibition with appropriate example. (ii) An enzyme has a K_M of $4.5 \times 10^{-5} \text{ M}$. If the V_{max} of the preparation is $20 \mu\text{moles litre}^{-1} \text{ t}^{-1} \text{ Mole}^{-1}$, what velocity would be observed in the presence of $2 \times 10^{-4} \text{ M}$ substrate and $4.5 \times 10^{-4} \text{ M}$ inhibitors of

- (a) a competitive inhibitor
- (b) a non-competitive inhibitor
- (c) an un-competitive inhibitor. K_i in all three cases is $3 \times 10^{-5} \text{ M}$.
- (d) what is the degree of inhibition in all the three cases.

(4)

6. (i) Describe the Claude process with a schematic diagram.

(ii) A Carnot engine working between a high-temperature source at 373 K and low temperature sink at 275 K and receives 50 kJ of heat from high-temperature region. Determine

(a) the minimum work required

(b) efficiency and

(c) amount of heat rejected.

(iii) The heat capacity at 1 atm pressure of solid magnesium in the temperature range of 0 to 560°C is given by the expression

$$C_p = 6.2 + 1.33 \times 10^{-3}T + 6.79 \times 10^4 T^2 \text{ cal/deg. gm atom}$$

Determine the increase of entropy, per gm atom, for an increase of temperature from 300 K to 800 K at 1 atm pressure.

7. (i) Show that in an ideal solution, solute follows Henry's law and solvent follows Raoult's law.

(ii) What is the significance of activity coefficient?

(iii) An organic compound is twice more soluble in ether than water. Calculate the amount of the compound extracted when 100 ml of aqueous solution containing 1g of compound is shaken with

- (a) 100 ml of ether at one time
(b) Two successive quantities of 50 ml each.

6+3+5

Q. No. BT - 503 / 091

B. Tech/Odd
2016-17/Reg

2016-17

**INDUSTRIAL MICROBIOLOGY &
ENZYME TECHNOLOGY**

BT - 503

Full Marks : 70

Time : Three Hours

All questions carry equal marks.

Group - A

Answer any two questions.

1. (a) What is del factor ? 1
 - (b) What are the techniques of enzyme immobilization ? 4
 - (c) How α -amylase is produced by solid state fermentation ? 4
 - (d) How 6-APA can be produced from penicillin G ? 3
 - (e) How penicillin is purified from fermentation broth ? 2½
 - (f) How methyl ketone is produced by fermentation ? 1½
 - (g) What is the reaction catalysed by dextranase enzyme for production of dextran ? 1½
2. (a) What are the parameters for selection of filtration system for a fermentation broth ? 3
 - (b) What type of centrifuges is used for cell separation from fermentation broth ? 2

P.T.O.

(2)

- (c) How citric acid can be produced by surface culture method ? Discuss the product recovery process. 3+2
(d) How acetic acid is produced in a trickling generator ? 2
(e) What are the phases in production of riboflavin by fermentation ? 2
(f) Discuss the process of ethanol production from starchy raw materials. 3½
3. (a) What are the criteria for selection of industrial fermentation media ? 3
(b) What are the desired properties for an antifoam agent for use in industrial fermentation ? 3
(c) Describe the Symba process for production of single cell protein. 3
(d) How the air supply system of an industrial fermenter is sterilized ? 3
(e) What types of spargers are used in a fermenter ? 2
(f) Draw a fermenter with a single multi-bladed impeller and mention the geometrical ratios used in fermenter design. 3½

(3)

2. Define Primary and secondary metabolites. Briefly discuss the control of microbial metabolism by regulating enzyme synthesis via Induction repression and attenuation. 3+4
3. State the difference between spontaneous mutation and induced mutation. Define Auxotrophic mutant. What are the strategies to screen the desired mutants during strain development by mutation ? 2+2+3
4. Describe protoplast fusion. What enzymes are used and with example explain why it is considered an important tool for strain improvement? 3+4
5. Name the types of genes controlling secondary metabolites production. How enzyme activity can be regulated ? Define genetic recombination 2+2½+2½
6. What is Site Directed Mutagenesis ? Explain with example Oligonucleotide mediated Site Directed Mutagenesis. Discuss the protein engineering strategy to improve the stabilisation of T4 Lysozymes. 2+3+2
7. Define gene expression. Using plasmid as vector discuss briefly the steps involved in introducing an important character to the host cells to be utilised industrially. 2+5
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Group - B

Answer any five questions. 5×7=35

1. State the importance of Industrial Microbiology with examples. What do you mean by strain improvement ? How strain improvement can be achieved ? Why it is needed ? 2+2+2+1

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Q. No. BT - 540 /

B. Tech./Odd
2016-17/Reg

2016-17

MINERAL BIOTECHNOLOGY

(Open Elective - 1)

BT - 540

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer the following questions. (Any seven) $10 \times 7 = 70$

1. (i) With the help of chemical reactions, explain the process of uranium bioleaching.
(ii) Schematically describe the processes of in situ bioleaching, heap and dump leaching. 5+5
2. (i) Describe the use of sulphur reducing bacteria to control the acid mine drainage.
(ii) Explain the terms autotropy, heterotropy, chemotropy, lithotropy and organotropy. 5+5
3. (i) Define bioleaching. Differentiate between bioleaching and biobeneficiation.
(ii) Describe the role of *Desulfovibrio* in mineral engineering applications. Why is 'vibrio' a part of its name? (2+3)+(4+1)
4. (i) Differentiate selective and differential media with suitable example.

P.T.O.

(2)

(ii) List the different the influencing factors of the bioleaching process.

5. (i) How is silicon removed from low-grade bauxite ores in extraction of aluminium?

(ii) Describe the benefits of using mixed cultures over the pure cultures or chemical methods in the extraction of zinc.

6. (i) Describe the leaching kinetics in the dissolution of mineral from ore in shrinking core model.

(ii) Describe the different mechanism of bioleaching in detail.

7. (i) What are essential nutrition requirements for bacterial growth ?

(ii) What is meant by the term "microaerophilic" ?

(iii) How does bacterial adaptation to mineral ores (concentrates) and toxic metal ions influence surface attachment and bioleaching efficiency?

8. (i) Why metal-tolerant strains are needed? How adapted strains are acquired?

(ii) Describe the role of corundum-adapted strains of *Bacillus polymyxa* in the separation of hematite and alumina.

(iii) Why hydrometallurgical extraction of copper is beneficial than pyrometallurgical extraction of copper from low grade ore ?

(3)

9. (i) Describe in detail the cyanidation process of gold recovery.

(ii) Name the five kingdoms in Whittaker's system of classification. How does the six kingdom concept differ from Whittaker's system?

(iii) What are the three major criteria that form the basis of the kingdoms in Whittaker's system? $4+(2+1)+3$

2016-17

STRUCTURAL ANALYSIS - II

CE - 501

Full Marks : 70

Time : Three Hours

First Half

Answer question 1 and any two from the rest.

1. Solve the following questions and write the correct answer
(Use once each of Slope-deflection, Moment distribution,
Kani's, Column analogy and consistent deformation
methods : $3 \times 5 = 15$)

- (i) A plane frame is loaded as shown in Fig.-Q1a. The
rotations are indicated as θ_B and θ_C and the sway is
indicated by the system Δ . For this frame which one of
the following statements is correct?

- (a) $\theta_B = \theta_C; \Delta$ is present,
(b) $\theta_B = \theta_C; \Delta$ is absent,
(c) $\theta_B = -\theta_C; \Delta$ is present,
(d) $\theta_B = -\theta_C; \Delta$ is absent.

PT.O.

(2)

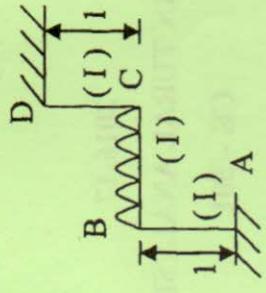


Fig.-Q1b

- (ii) For the rigid frame shown in the Fig.-Q1b, the force required for moving the girder BC through a horizontal displacement Δ is given by

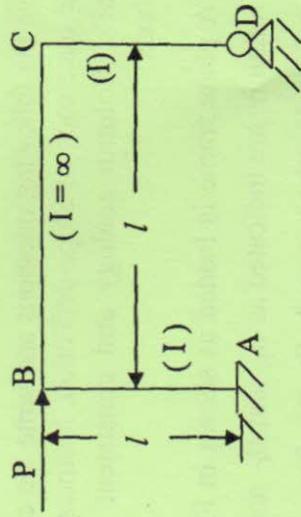


Fig.-Q1b

- (a) $6EI\Delta/l^3$
(b) $8EI\Delta/l^3$
(c) $9EI\Delta/l^3$
(d) $15EI\Delta/l^3$

(3)

- (iii) If the reference height is 6.0m, the sway distribution factor for member AB for the frame in Fig.-Q1c is equal to

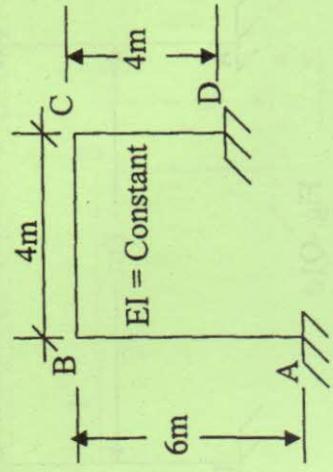


Fig.-Q1c

- (a) $-8l/70$
(b) $-31/36$
(c) $31/36$
(d) $12/35$

- (iv) The maximum deflection of a fixed beam of span L of uniform section carrying a central load W is equal to
- (a) $WL^3/48EI$
(b) $WL^3/96EI$
(c) $WL^3/192EI$
(d) $5WL^3/384EI$

(4)

- (v) For the frame shown in the Fig.-Q1d, the maximum bending moment in the column is

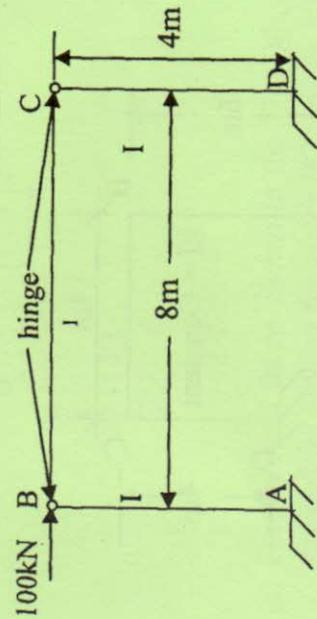


Fig.-Q1d

- (a) zero
- (b) 400 kN-m
- (c) 100 kN-m
- (d) 200 kN-m

(5)

2. A rigid jointed frame ABCD of varying moment of inertia is shown in Fig.Q2. During fabrication, support A sinks by 1.5 cm. Find the support moments and draw B.M. diagram using either slope-deflection method or moment distribution method. Take $EI = 48000 \text{ kN-mm}^2$. 10

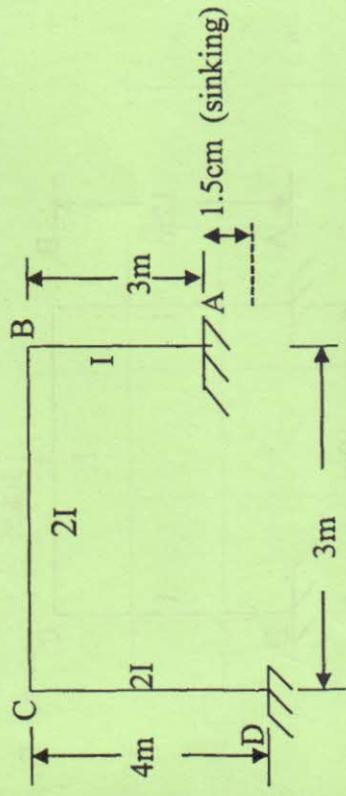


Fig.-Q2

3. Analyse the portal frame ABCD with fixed base as shown in Q2 when there is no sinking of support A but a vertical central load of 40 kN is applied on horizontal member BC. Use Kani's rotation contribution method. Draw B.M. diagram. 10

(6)

4. Analyse the fixed base portal frame ABCD with a central concentrated load on BC as shown in Fig.Q4 having equal flexural rigidity of all the members. Use column analogy method or consistent deformation method for the analysis of the frame. Draw B.M. diagram. 10

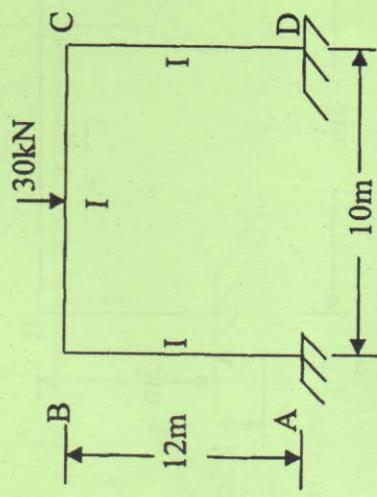


Fig.-Q4

5. A semi-circular beam ACB of uniform cross-section is fixed at A and B laying on a horizontal plane as shown in Fig.Q5. It is subjected to a downward vertical concentrated load W at C. Show that the sagging moment at section C of the beam is WR/π if the cross-section of the beam is circular. Also find the expression for the deflection of C. 10

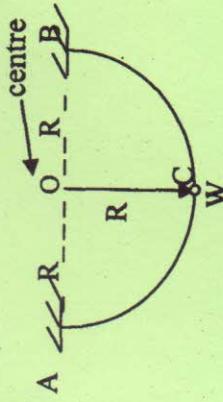


Fig.-Q5

(7)

Second Half

Answer either Question No.Q6 or Q7 and any two from the rest.

6. Analyze a two storey, three bay frame subjected to a lateral load at each storey by cantilever method. The cross-sectional areas of the columns are all assumed to be equal. (Fig. Q6) 11

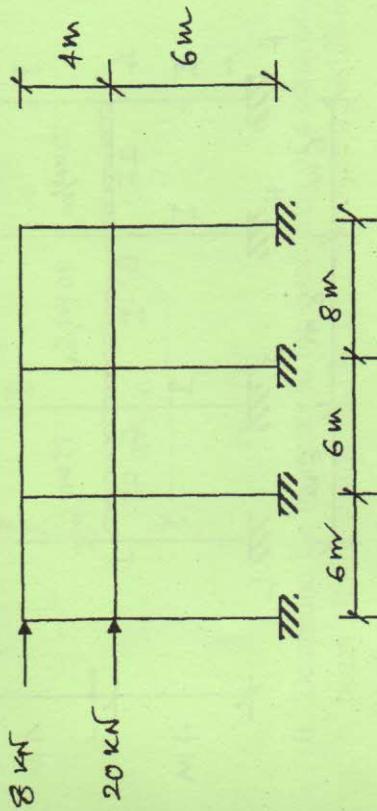


Fig.-Q6

P.T.O.

(8)

Or,

7. The substitute frame for a typical intermediate floor in a building frame is shown in Fig.Q7. Analyze the frame for gravity loading as shown and draw bending moment diagram.

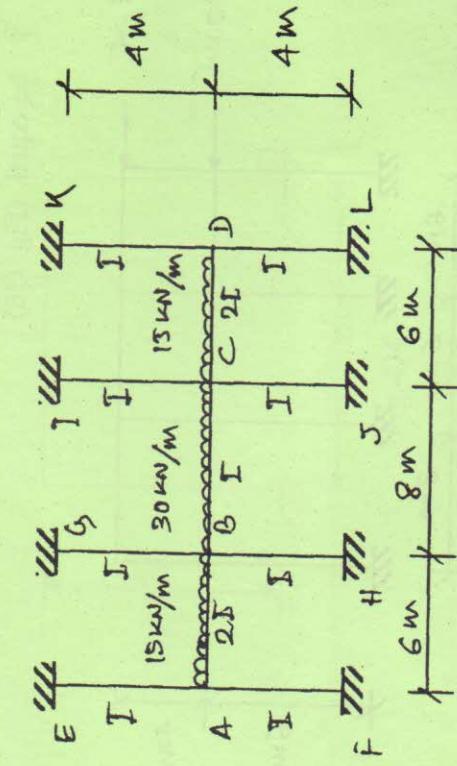


Fig.-Q7

8. Draw the influence lines for bending moment at mid-point of AB for continuous beam ABC (Fig. Q8). EI is same throughout. Obtain ordinates at 2 m intervals.

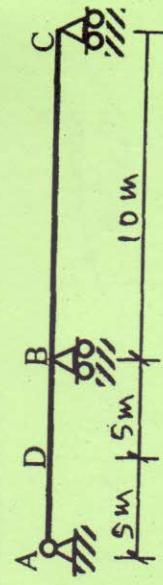


Fig.-Q8

(9)

9. Calculate the moment at the fixed support of the frame shown below when loaded with a uniformly distributed load of 25 kN/m by applying Flexibility method.

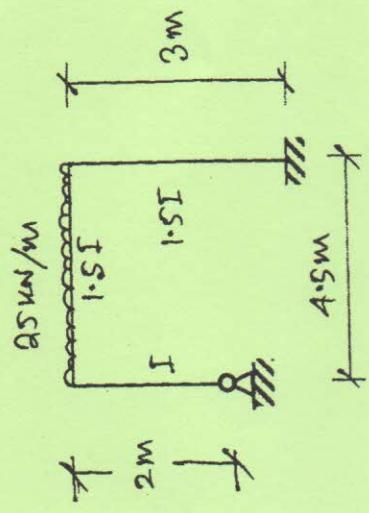


Fig.-Q9

10. Determine the moments at the fixed ends of a continuous beam shown below in Fig Q10 by applying stiffness method.

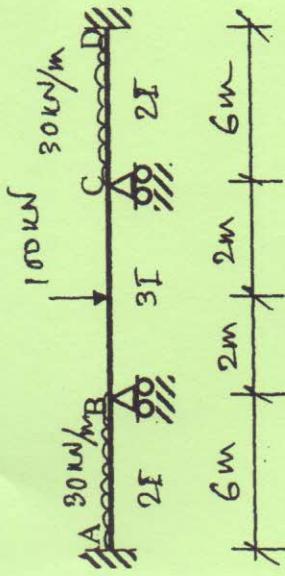


Fig.-Q10

Q. No. CE - 502 / 086

**B. Tech./Odd
2016-17/Reg**

2016-17

DESIGN OF STEEL STRUCTURES-I

CE - 502

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer to the point and brief

Use of IS : 800-2007 and IS : 808-1989 is permitted only

Assume any suitable data, if not supplied

Grade of steel $f_y = 250$ MPa

First Half

2 marks is allotted for neatness.

1. (a) Determine the tensile capacity of double angle section 2L 100 × 75 × 8 connected back to back with longer leg to a gusset plate 10mm thick. Use 4nos. 20dia bolts of grade 4.6. Pitch = 50mm, edge distance = 40mm, gauge distance = 50mm.
- (b) An angle L90×90×8 is used as a strut in a truss. The length of the strut between the intersections at each end is 3.0m. Calculate the strength of the strut when it is connected by two bolts at each end with one leg to the gusset plate. Assume fixed end condition. 7+6
2. Design a laterally unsupported beam having effective span = 4m, subjected factored bending moment 550kNm and factored shear force 200kN including the self weight.

P.T.O.

(2)

(3)

Second Half

Design a simply supported steel joist (ISMB section) of 5.0m effective span is laterally supported throughout. It carries a total uniformly distributed load of 60kN (inclusive of self weight). In case, the designed section is subjected to high shear($=0.65V_d$), also estimate its moment capacity.

3. Check the suitability / strength of ISMB400 as gantry girder supporting an EOT crane having the following details.

Capacity of the crane = 60kN,

Longitudinal spacing of column = 5m,

Center to center distance of gantry girder = 12m,

Wheel spacing = 3.5m,

Edge distance = 1.2m,

Self weight of crane girder = 5kN/m and

Weight of trolley car = 15kN.

Or

Design a welded plate girder 24m span and laterally restrained throughout. It has to support a uniform load of 100kN/m throughout the span exclusive of self-weight. Design the girder without intermediate stiffener. Design the cross section and the end load bearing stiffener.

Answer question No 1 and any *two* questions from the rest.

1. Design a lacing system for the column 12m long to carry a factored axial load of 1600kN. The Column is restrained in position but not in direction at both ends. Provide singeing system.

- (i) Design the lacing system with bolted connections keeping the two channels back-to-back.
- (ii) Design the lacing system with welded connections keeping the two channels back-to-back.
- (iii) Design the batten system with bolted connections keeping the channels toe-to-toe.

2. A non-sway column in a building frame with flexible joints is 5m high and subjected to a factored axial load of 653 kN and a factored moment of 35 kNm at the top of the column and 55 kNm at the bottom of the column. Design a suitable Beam-column, assuming $f_y = 250$ N/mm 2 . Take the effective length of the column as 0.8L along both the axis.

3. (a) Discuss the upper bound theorem and lower bound theorem in plastic collapse.

(b) Determine the plastic moment capacity and shape factor of the I section about z-z axis and y-y axis. This section is ISMB400 with root radius omitted. Assume $f_y = 250\text{Mpa}$.

(4)

4. (a) Design the base plate for an ISHB 250 column subjected to a factored moment of 47kNm and a factored axial load of 560kN. Assume Fe410 grade steel and M25 grade concrete ($f_{ck} = 25 \text{ N/mm}^2$)

- (b) Redesign the base plate using gusset plate for an ISHB 250 column subjected to a factored moment of 47kNm and a factored axial load of 560kN. Assume Fe410 grade steel and M25 grade concrete ($f_{ck} = 25 \text{ N/mm}^2$)

3+5

Q. No. CE - 503 / 081

**B. Tech./Odd
2016-17/Reg**

2016-17

ENVIRONMENTAL ENGINEERING - I

CE - 503

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer all parts of a question in one section of the answer script only. Use neat sketches whenever required.

Assume standard values of any data not supplied.

Answer any *five* questions.

1. (a) What are the effects of impoundment of water in a reservoir?
- (b) For the following population data, determine the probable population in the years 2020 & 2030 by all four analytical methods :

Year	1980	1990	2000	2010
Population	10000	14000	19000	24500

$$4+10=14$$

2. (a) State the assumptions and derive the standard expression for estimating the discharge from a well sunk in an unconfined aquifer.

- (b) What are the different types of tubewell? Describe them with neat sketches and discuss their suitability.

$$7+1+6=14$$

P.T.O

(2)

3. (a) A water treatment plant treats 30×10^6 lpd of water using coagulation — sedimentation tanks. The dosage of filter alum is 20mg/l. If the alkalinity of raw water is equivalent to 4.5mg/l of CaCO_3 , determine the quantity of filter alum and quick lime (containing 80% of CaO) required per month by the plant. Take molecular weights as : $\text{Ca} = 40$; $\text{C} = 12$; $\text{S} = 32$; $\text{O} = 16$; $\text{Al} = 27$ & $\text{H} = 1$.
- (b) Derive an expression for the correction factor to be used in estimating the flow of water in a closed pipe network by Hardy-Cross Method. $10+4=14$

4. (a) Compute the storage needed for an impounding reservoir from the following records of mean monthly runoff values for a constant draft of 300 million litres per month. Use mass curve method.
- | Order of the month | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|------|------|-----|-----|----|----|----|
| Observed monthly mean runoff (million litres) | 1300 | 1400 | 700 | 100 | 80 | 30 | 10 |
- (b) Derive an expression for the correction factor to be used in estimating the flow of water in a closed pipe network by Hardy-Cross Method. $10+4=14$

(3)

- (b) Briefly explain the following with respect to a rapid sand gravity filter :

(i) Method of revival of filter media.

(ii) The operational troubles that may develop in this filter. $8+2+4=14$

6. (a) A pipe line 0.8m in diameter is 2.5km long. To increase the discharge, another pipeline of the same diameter is introduced parallel to the first in the second half of its length. Find the increase in discharge with the head at the inlet as 30m. Use Darcy-Weisbach formula with $f = 0.04$.

- (b) Discuss the factors to be considered in locating a typical reservoir intake. Draw a neat sketch to show the various features of a wet intake employed for the same. $7+3+4=14$

7. (a) A settling tank is designed to have a surface overflow rate of 32 m/d. Determine the overall removal obtained for a water sample with the following particle size distribution. The specific gravity of the particles is 1.2, the dynamic viscosity is 1.027×10^{-2} gm/cm-sec and the density is 0.997 gm/cc.

Particle size (mm)	0.1	0.08	0.07	0.06	0.04	0.02	0.01
Weight fraction greater than size (%)	10	12	38	72	90	97	100

- (b) What bacteriological standards are to be maintained in a water supply system? What is MPN? $10+3+1=14$
5. (a) Describe with neat sketches and compare the different layouts in water distribution system.

(4)

- (b) Give flowsheets of water treatment processes to be employed for each of the following types of sources of raw water : (i) hilly stretch of a river, and (ii) the flat stretch approaching the confluence with sea. Give reasons for adopting these arrangements. $8+6=14$

8. Write short notes on the following : $2\times 5+4=14$

- (a) Rising main;
 - (b) Penstock;
 - (c) 'Tee' as a pipe fitting;
 - (d) Charging systems used in water supply;
 - (e) Ferrule connection;
 - (f) Break point chlorination.
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Q. No. CE - 504 / 079

B. Tech./Odd
2016-17/Reg

2016-17

HYDROLOGY AND IRRIGATION ENGINEERING

CE - 504

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer all questions.

Marks against each question are indicated on the right hand side.

1. Draw neat diagram labelling the relevant terms in the diagram. Each question carries two marks. 20
 - (a) Horton's Representation of the Hydrological Cycle.
 - (b) Recording from a Natural Syphon-type Gauge (Schematic).
 - (c) Energy balance in a water body.
 - (d) Running's Method for estimation of the constant "a" for Permanent control for Stage — Discharge Curve.
 - (e) Reservoir Regulation Effect on a hydrograph.
 - (f) Role of drainage density on a Hydrograph.
 - (g) Direct irrigation scheme.
 - (h) Border Strip Method for Irrigation.

(2)

- Drip Irrigation Scheme.
 - Classes for Soil Water.
 - Give formula for each process mentioned below : Explain each term in the formula. Each question carries one mark.
- 10
- Radar Measurement of Rainfall.
 - Weibull Formula for frequency analysis of rainfall in a time series.
 - Blaney-Criddle Formula for determination of Potential Evapotranspiration.
 - For a rough turbulent flow, the velocity distribution n a stream across a vertical section.
 - Discharge equation to take into consideration the unsteady flow effect.
 - For the sake of base flow separation, time interval from the peak to the point where discharge is normal for the river.
 - Available moisture depth (Depth of water stored in root zone)
 - Delta for irrigation water in metric unit.
 - Consumptive use efficiency for irrigation water.
 - Kennedy's equation for critical velocity in a canal.
3. (a) A catchment area has seven rain gauge stations. In a year the annual rainfall recorded by the gauge area as follows :

(3)

Station	A	B	C	D	E	F	G
Rainfall (cm)	130.0	142.1	118.2	108.5	165.2	102.1	146.9

For a 5% error in the estimation of the mean rainfall, calculate the minimum number of additional stations required to be established in the catchment.

5

Or,

The normal annual precipitation of five raingauge stations P, Q, R, S, T are 125, 102, 76, 113, and 137 cm respectively. During a particular storm, the precipitation recorded by station P, Q, R, and S are 13.2, 9.2, 6.8, and 10.2 cm respectively. The instrument at station T was in-operative during that storm. Estimate the rainfall at station T during that storm.

5

(b) On the basis of isohyetal maps, the 50-year - 24 hour maximum rainfall at Durgapur is found to be 16.0 cm. Determine the probability of a 24-hour rainfall of magnitude equal to or greater than 16.0 cm occurring at Durgapur :

5

- Once in 10 successive years,
 - Two times in 10 successive years, and
 - At least once in 10 successive years.
- Or,

A one-day rainfall of 15.0 cm at a place A was found to have a return period of 100 years. Calculate the

(4)

probability that a one-day rainfall of this or larger magnitude : 5

- (i) Will not occur at A during the next 50 years, and
- (ii) Will occur in the next year.

(c) A reservoir had an average surface area of 20 sq. km. during June 2008. In that month the mean rate of inflow is $10 \text{ m}^3/\text{s}$, mean outflow is $15 \text{ m}^3/\text{s}$, monthly rainfall is 10 cm and change in storage is 16 million cubic meter. Assuming the seepage losses to be 1.8 cm, estimate the evaporation in that month. 5

Or,

The rainfall on five successive days on a catchment was 2, 6, 9, 5 and 3 cm. If the ϕ index for the storm can be assumed as 3 cm/day, find the total surface runoff. 5

4. (a) Long term observation at a stream flow-measuring station at the outlet of a catchment in a mountainous area gives a mean annual discharge of $65 \text{ m}^3/\text{s}$. An isohyetal map for the annual rainfall over the catchment gives the following areas closed by isohyets and the divide of the catchment 5

Isohyet (cm)	140-	135-	130-	152-	120-	115-	110-	
Area (km^2)	50	300	450	700	600	400	200	

Calculate (a) the mean annual depth of rainfall over the catchment, (b) the mean annual runoff and (c) the runoff coefficient. 5

(5)

(b) During a flood flow the depth of water in a 10m wide rectangular channel was found to be 3.0 and 2.9 m at two sections 200 m apart. The drop in the water surface elevation was found to be 0.12 m. Assuming Manning's coefficient of 0.025, calculate the flood discharge through the channel. 5

(c) The ordinates of a 6-h unit hydrograph are as given below :

Time (h)	0	6	12	18	24	30	36	42	48	54	60	66
Ordinate of 6-h U.H (m^3/s)	0	20	60	150	120	90	66	50	32	20	10	0

If two storms, each of 1-cm rainfall excess and 6-h duration occurs in succession, calculate the resulting hydrograph of flow. Assume the base flow to be uniform at $10 \text{ m}^3/\text{s}$.

Or,

The ordinates of a 2-h unit hydrograph are given below :

Time (h)	0	2	4	6	8	10	12	14	16	18	20	22
Ordinate of 2-h U.H (m^3/s)	0	25	100	160	190	170	110	70	30	20	6	0

Determine the ordinates of an S-curve hydrograph and using this determine the ordinates of a 4-h unit hydrograph. 5

(6)

5. (a) A water course commands an irrigated area of 600 hectares. The intensity of irrigation of rice in this area is 60%. The transplantation of rice crop takes 12 days and total depth of water required by the crop is 50 cm on the field during the transplantation period. During the transplantation period the useful rain falling on the field is 10 cm. Find the duty of irrigation water for the crop on the field during transplantation at the head of the field and also at the head of the distributary, assuming losses of water to be 20% in the water course. Also calculate the discharge required in the water course. 5

Or,

A field channel has culturable command area of 2000 hectares. The intensity of irrigation for gram is 30% and for wheat is 50%. Gram has a kor depth of 12 cm and kor period of 18 days, while wheat has a kor period of 15 days and a kor depth of 15 cm. Calculate the discharge of the field channel. 5

- (b) Design a channel section for the discharge of 30 cumecs, silt factor of 1.00, side slope of 0.5 : 1. Find also the longitudinal slope. 5
-

Q. No. CE - 543 / 040

B. Tech./Odd
2016-17/Reg

2016-17

INTRODUCTION TO EARTHQUAKE ENGINEERING

CE - 543

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any six including Q.7.

1. An electronic instrument in an aircraft has a mass of 20kg is to be isolated from engine vibration ranging from 2000 to 2200 cycles per minute. Mounting of the equipment is required to give an isolation of 80%. Assuming damping of the system 2%, calculate the springs of the mounting. For which frequency the board has to be design and why? 10

2. (a) A system vibrating with a natural frequency of 6Hz starts with initial amplitude of 5cm and velocity 25cm/sec. Determine the natural period, Amplitude, damped period, maximum velocity and acceleration.
(b) Plot the graphs between DLF vs frequency ratio and discuss the salient points. 6+4

3. Enumerate different building irregularities and the remedial measures with diagram for earthquake resistant RC buildings. 10

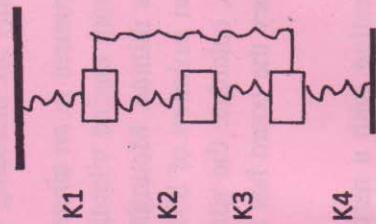
P.T.O.

(2)

4. Find the response due to a half sinusoidal loading by
classical or Duhamel integral. 10

5. (a) What are the effects of earthquake? Why are
earthquakes not predictable?

(b) Find the mass matrix and stiffness matrix for the system
shown in figure below (Masses are M₁, M₂ and M₃
from top respectively while stiffness as shown in the
figure). 5+5



(3)

7. Write short notes on (any four) :

- (a) Seismograph and seismometer
- (b) Magnitude and Intensity
- (c) Epicenter and hypocenter
- (d) Tectonic theory
- (e) Magnitude and Energy of Earthquake.

5×4

6. An elevated water tank of 3 m height is modeled as
SDOF with seismic mass 500kg. Find the lateral force at
the top and bending moment at the base level, if the water
tank is in Durgapur ($Z = 0.16$, $I = 1.5$, $R = 5$ multiplication
factor for 5% damping is 1). $E = 2.1 \times 10^6 \text{ kg/cm}^2$ and
 $I = 1300 \text{ cm}^4$

$$\begin{aligned} S_a/g &= 1 + 15T \quad \text{for } T = 0 - 0.1 \\ &= 2.5 \quad \text{for } T = 0.1 - 0.4 \\ &= 1.36/T \quad \text{for } T = 0.4 - 4.0 \end{aligned}$$

10

Q. No. CH - 501 / 075

**B. Tech./Odd
2016-17/Reg**

2016-17

MATHEMATICAL MODELLING AND SIMULATION

CH - 501

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer five questions taking at least two from each section

Assume all missing physical data
appropriately with suitable notation.

Section - A

1. (a) Differentiate the steps to formulate the fundamental modelling and empirical modelling. Give examples where the deterministic model and the stochastic model are applicable. **6**

(b) Describe the lumped parameter and distributed parameter system with respect to physical characteristics, model equation and solution techniques. **8**
2. A variable hold up constant cross-sectional non-isothermal CSTR is used to carry out the liquid phase chemical reaction. $A \rightarrow P$, the reaction is second order. A long frictional connecting tube with rough internal surface is used for product withdrawal. The liquid density is almost constant for the entire operating range. Develop the necessary model equation for estimation of state variables

(2)

of the system. Write down the suitable computer code to solve the model equations.

14

3. What is multi-component flush drum ? Develop the steady state model using MESH equation ? Discuss with necessary equation how the unsteady state model can be developed using the information from steady state model.

7+7

4. (a) What is shooting technique? Discuss how it can be used to solve an algebraic equation ?

(b) A 2nd order liquid phase chemical reaction is taking place in 4 staged CSTR, with volume of 8m^3 for each stages. Reactant A and B are entering the reactor system $40\text{ m}^3/\text{s}$ with inlet concentration of 1.5 mol/m^3 . A is entering at first stage while B is entering through the last stage. The reaction rate constant is $150\text{ m}^3/\text{mol.s}$. Calculate the outlet concentration of both the streams and conversion from each stages.

3+11

(3)

6. (a) Discuss with necessary derivation the difference between the Neumann and Dirichlet boundary condition. Show the steps to implement the conditions during solution stage of a general conservation equation.

(b) Define the terms: control volume, node, and diffusion path length and flow area for finite volume method. What is boundary nodes? Show the necessary equation for implementing the boundary condition with heat transfer due to radiation.

7+7

7. Ammonia gas is diffusing through a circular tube of uniform cross-section, the tube is packed with packing material and is filled with air, the effective diffusivity of ammonia in air is D_e . The packing material adsorbs $5 \times 10^{-2}\text{ mole/m}^3\cdot\text{s}$. If concentration of ammonia in one end of the tube is c and tube is long enough so that in other end variation of ammonia concentration with length is negligible. Derive the unsteady state model equation with suitable boundary and initial conditions. Discuss a suitable technique along with necessary code to solve the model equations.

14

8. A uniform cross-sectional circular metallic rod is exposed to a hot environment maintained at temperature 500°C is exchanging heat by convection with heat transfer co-efficient $10\text{ J/m}^2\cdot\text{s}$. The two ends are maintained at insulated condition. The initial temperature of the rod was 30°C , the thermal conductivity of the metal is 150 W/m.K and the length of rod is 2.0 m . Assume all other data. Derive the necessary equation along with the boundary conditions to evaluate the steady state temperature distribution along the length of the rod. Write a suitable program to solve the model equation (use finite volume technique).

14

Section - B

5. (a) Two liquid holding tank is connected by a frictional pipe of length L and diameter d_p . There is an inlet at the first tank and outlet from the 2nd tank using a constant speed pump. Develop the unsteady state model equation to calculate liquid level in each tank, when the inlet in 1st tank is stopped suddenly.

7

(b) Write a suitable program to solve the model equations. Draw the state variable vs. time graph. Calculate the time to reach the system at steady state.

7

Q. No. CH - 502 / 077

B. Tech./Odd
2016-17/Reg

2016-17

CHEMICAL REACTION ENGINEERING - I

CH - 502

Full Marks : 70

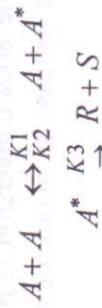
Time : Three Hours

The figures in the margin indicate full marks.

Group - A (35 marks)

Answer any two questions.

1. (a) Decomposition of A at 400°C and 1 atm follows a first order rate law. Show that a non-chain transition complex mechanism is consistent with the observed kinetics



- (b) The data for half-life period for the decomposition of ammonia in contact with tungsten are furnished below. Find the order of the reaction.

Pressure, mm Hg	50	100	200
t _{1/2} , h	3.52	1.82	0.93

- (c) Show from the following experimental results that the decomposition of H₂O₂ in aqueous solution is a first order reaction. Calculate the rate constant.

P.T.O.

(2)

t , min	0	10	20	30	40
N, ml	25	20	15.7	12.5	9.6

N is the volume of KMnO_4 required to decompose a definite volume of H_2O_2 solution. It may be assumed to be proportional to the concentration. $7+4\frac{1}{2}+6=17\frac{1}{2}$

2. (a) Deduce the stability criterion in a nonisothermal unsteady-state CSTR. What is limit cycle? What factors does it depend on?

- (b) A second order chemical reaction is carried out in a single CSTR results in 80% conversion. It is proposed to arrange another similar CSTR in series with the first one. All the parameters remain the same.

- (i) Calculate the resulting conversion, if the volumetric flow rate remains the same.

- (ii) If the same 80% conversion is maintained, what will be the increase in volumetric flow rate?

$$8\frac{1}{2}+9=17\frac{1}{2}$$

3. (a) A is cracked in vapour phase to B and C; $A \rightarrow B+C$. The reaction is of first order. The rate constant is $\ln k = 34.34 - 34222/T$.

- 8000 kg of pure A is fed to the reactor per hour to an adiabatic tubular reactor at 1035 K and 162 kPa. Calculate the volume of the reactor for 20% exit conversion.

$$M_A = 58 \times 10^{-3} \text{ kg/mol}$$

$$\Delta H^\circ(298 \text{ K}) = 80770 \text{ J/mol}$$

$$C_{PA} = 26.63 + 0.183 T \text{ J/mol/K}$$

(3)

$$C_{PB} = 20.04 + 0.0945 T \text{ J/mol/K}$$

$$C_{PC} = 13.39 + 0.077 T \text{ J/mol/K}$$

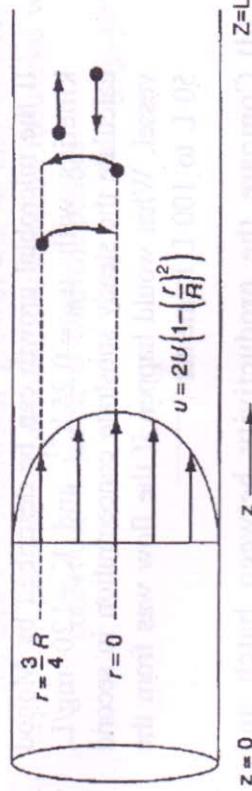
- (b) A vapour phase reaction $A \rightarrow 4R$ is carried out in a PFR. Calculate the space time needed for 75% conversion. The feed concentration of A is 0.08 mol/L. $(-r_A) = 0.4 C_A^{0.5} \text{ mol/L.s.}$ $11\frac{1}{2}+6=17\frac{1}{2}$

Group - B

Answer any one

All the questions have equal credit of $17\frac{1}{2}$

4. For the flow reactor given in the following figure, derive the Equation for Taylor-Aris Dispersion.



5. For the series reaction A-B-C in an isothermal CSTR, find the concentration of C_A , C_B and C_C varying with time using Eigen method. The reactor volume is V ; rate constants are K_1 and K_2 . Volumetric flow rate is Q and C_A at inlet is C_{A0} .

6. Describe the design procedure of a recycle reactor.

(4)

Group - C

Answer any one

7. (a) What do you mean by constant environment fermentation? Explain with a neat sketch the function of an enzyme in fermentation process.

- (b) Discuss Michaelis-Menten model kinetics of enzyme fermentation reactions in light of substrate and enzyme concentration.

- (c) Two continuous stirred-tank fermenters are connected in series, the first having an operational volume of 100 L and that of the second being 50 L. The feed to the first fermenter is sterile and contains 5000 mg/L of substrate, being delivered to the fermenter at 18 L/h. If the microbial growth can be described by Monod kinetics with $\mu_m = 0.25 \text{ h}^{-1}$ and $K_s = 120 \text{ mg/L}$, calculate the steady substrate concentration in second vessel. What would happen if the flow was from the 50 L to 100 L fermenter?

- (d) Compare the productivity between batch and continuous bioreactor and give your comments on result.

8. (a) Enumerate the procedure to estimate the maximum rate of reaction and Michaelis-Menten constant for the enzymatic conversion of urea in batch or plug flow fermenter.

- (b) Explain the importance of washout condition in a constant stirred tank fermenter connected in series with the help of mathematical expression.

(5)

- (c) The steady state substrate and biomass concentration for a CSTR operated at different dilution rate are given below. Fresh feed concentration is 700 mg/L. Calculate the kinetic parameters.

Dilution rate, D/hr	S [mg/L]	X [mg/L]
0.30	45	326
0.25	41	328
0.2	16	340
0.12	08	342
0.08	3.8	344

- (d) Draw a microbial growth curve and discuss its importance in microbial fermentation industries and concentration profile at different periods.

5+5+5+2½

Q. No. CH - 503 / 073

**B. Tech/Odd
2016-17/Reg**

2016-17

MASS TRANSFER - I

CH - 503

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Assume any suitable value if there is any absence of data.

Section - A

(35 Marks)

Question No.1 is compulsory.

Answer any *two* questions from the rest.

1. Answer any *five* of the following :

- (a) "The basic principle for design of mass transfer equipment is to minimise the contribution of molecular diffusion" — Justify the statement.
- (b) Fick's law cannot be directly used for mass transfer equipment design calculation — Explain the statement.
- (c) Justify the following that the diffusivity of air-ammonia system is higher ($1.98 \times 10^{-5} \text{ m}^2/\text{s}$) than the diffusivity of air-ethanol vapour ($1.02 \times 10^{-5} \text{ m}^2/\text{s}$) both at 1 at 0°C and 1 atm. pressure. (ii) The diffusivity of air-water vapour at 0°C and 1 atm pressure is $2.58 \times 10^{-5} \text{ m}^2/\text{s}$. Estimate the diffusivity at 59°C and 2 atm pressure.

(2)

(d) In case of highly soluble gases in a liquid solvent, the overall mass transfer coefficient is nearly equal to the gas-phase mass transfer coefficient and in case of sparingly soluble cases the overall mass transfer coefficient is equal to solvent-phase mass transfer coefficient — Explain with reasons.

(e) A plait point condition in liquid-liquid extraction is analogous to azeotrope condition in distillation — Explain the significance of the statement.

(f) Select the types of extractor for the following cases with your justifications :

(i) The carrier solvent has a close density with extracting solvent and less residence time is required.

(ii) The extraction to be carried out within a limited number of stages.

(g) For effective extraction operation 'Selectivity' must exceed unity and cannot be effective at all if the value is equal to unity — Justify.

2. A drop of water 4.5 mm in diameter is suspended at the end of a thin wire, vaporizes in the ambient air at 1.013 bar pressure and 30°C dry-bulb temperature 25°C wet-bulb temperature. The thickness of the stagnant air-film surrounding the droplet is estimated to be 2.0 mm under prevailing condition. Assuming this film-thickness to be unchanged during vaporization, calculate the time required for disappearance of the water drop if the ambient air is stagnant. Given data :

(3)

Vapour pressure of water at 30°C, 25°C are 31.75 mm Hg and 23.69 mm Hg respectively. Diffusivity of water at 25°C 1 atm. pressure = $2.58 \times 10^{-5} \text{ m}^2/\text{s}$.

3. 1000 kg of water-dioxane solution having 25% dioxane and 75% water is to be extracted with pure benzene as extracting solvent to remove 90% of the dioxane present in the solution. The equilibrium distribution of dioxane between water and benzene at 25°C is given in the following table.

Equilibrium Data of the aforesaid system at 25°C are given in the following :

Weight fraction of dioxane in water	0.051	0.189	0.252
Weight fraction of dioxane in benzene	0.052	0.225	0.320

(a) Calculate the solvent required to conduct this extraction operation in a single stage.

(b) If the required solvent amount of the aforesaid amount is distributed in three equal stages. Estimate the percentage extraction using the three stage operation and compare between these two types of operations.

4. 2000 kilograms of an aqueous feed containing 50% by mass pyridine is contacted with the pure chlorobenzene as solvent. The mass ratio of the feed to solvent is 1 : 1.5 Calculate the mass and composition of the extract and also the percentage of pyridine in the raffinate. The equilibrium and tie line data are given below :

(4)

Aqueous phase (mass fraction) Chlorobenzene phase (mass fraction)

Water (A)	Chloro-benzene (B)	Pyridine (C)	Water (A)	Chloro-benzene (B)	Pyridine (C)
X_A	X_B	X_C	y_A	y_B	y_C
99.92	0.08	0	0.05	99.95	0
94.82	0.16	5.02	0.67	88.28	11.05
88.71	0.24	11.05	1.15	79.90	18.95
80.72	0.38	18.90	1.62	74.28	24.10
73.92	0.58	25.50	2.25	69.15	28.60
62.05	1.85	36.10	2.87	65.58	31.55
50.87	4.18	44.95	3.95	61.00	35.05
37.90	8.90	53.20	6.40	53.00	40.60
13.2	37.8	49.00	13.2	37.8	49.0

(5)

Group-B

(Marks - 35)

Answer Q.5 and any two of the rest of Group B.

(Q.5 is Compulsory)

5. (a) State the conditions on which the expression of mass transfer coefficient depends.

- (b) State the physical significance of HTU and NTU.

- (c) We know : $N_A = N_{x_A} + J_A$. Prove that the counterpart of this equation when expressed in terms of masses will take the form as follows :

$$M_A N_A = u p_A + M_A J_A. \text{ All the terms carry their usual meaning.}$$

6. (a) State the assumptions of Boundary Layer Theory. Discuss the reason why Boundary Layer theory is more acceptable than all other conventional theories.

- (b) Prove that for mass transfer from a gas into a thin liquid film falling down a vertical flat surface,
 $Sh_{av} \approx 3.41$ when film Reynolds number is less than 100. Mention explicitly all the assumptions made.

- (c) Estimate the rate of absorption of CO_2 into a water film flowing down a vertical wall 1 m long at the rate of 0.01 kg per second per meter of width at $25^\circ C$. The gas is pure CO_2 at 1 std atm. The water is essentially CO_2 free initially.

10

(6)

Given : The solubility of CO_2 in water at 25°C , 1 std atm is $0.03336 \frac{\text{kmol}}{\text{m}^3}$

$$D_{AB} = 1.96 \times 10^{-9} \frac{\text{m}^2}{\text{s}}. \text{ Solution density, } \rho = 998 \frac{\text{kg}}{\text{m}^3},$$

$$\text{Viscosity } \mu = 8.94 \times 10^{-4} \frac{\text{kg}}{\text{ms}}.$$
4+6+4

7. (a) Explain the 'Controlling resistance' for inter-phase mass transfer with suitable example.

(b) Derive the equation for determination of number of theoretical stages in a tray tower analytically when equilibrium and operating lines are straight and parallel.

(c) A counter-current absorption tower is being used for scrubbing a soluble gas from a dilute air-gas mixture. If the solute free solvent liquid is introduced at the top of the column, then show that number of overall gas phase transfer units required is given by

$$N_{\text{tot}} = \left[\frac{1}{\left(1 - \frac{mG_m}{L_m} \right)} \right] \ln \left[\left(1 - \frac{mG_m}{L_m} \right) \frac{y_1}{y_2} + \frac{mG_m}{L_m} \right]$$

Where equilibrium relation is given by $y^* = mx$; y_1 and y_2 are mole fraction of the solute at the inlet and outlet gas phases respectively. G_m and L_m are the gas and liquid flow rates in kmol/s.m^2 and x is mole

(7)

fraction of the solute in liquid phase. State explicitly all the assumptions you have made.

(d) At a particular section of an equipment for absorption of the solute 'A' in a liquid, the bulk gas phase contains 10 mol% A and the liquid contains 1.5 mol% of it. The gas film coefficient is $k_y = 9.0 \text{ kmol/(h)(m}^2)(\Delta y)$ and 70% of the mass transfer resistance occurs in the liquid-film when compared with 'overall mass transfer resistance' on the liquid phase basis. The

Henry's law applies, $y_A = 0.9x_A^*$. Calculate (i) the overall mass transfer coefficient, K_x ; (ii) the molar flux of A; and (iii) the interfacial concentrations of the solute, x_{Ai} and y_{Ai} .

8. (a) With a neat sketch deduce the condition of 'Downcomer flooding'.

(b) Discuss the reasoning behind considering the quantity $G/k_y \bar{a}(1-y)_{iM}$ nearly constant and calling it 'height of an individual gas phase transfer unit'. State the physical significance of HTU and NTU.

(c) It is required to absorb 95% of 'the acetone from a mixture with N_2 containing 1.5 mol% of the compound in a countercurrent tray tower. The total gas input is 30 kmol/hr and water enters the tower at a rate of 90 kmol/hr. The tower operates at 300K and 1 atm. The equilibrium relation is $y = 2.53x$. Determine the number of ideal trays necessary for this separation. Use Kremser analytical method.

(8)

- (d) A gas mixture having 7.0 mol% of the solute A is to be scrubbed in a packed tower at a rate of 70 kmol/h. The solvent, water, is fed at a rate of 80 kmol/h. In the concentration range involved, the solubility of the gas is described by the equation :

$y_A^* = 1.2x_A - 0.62x_A^2$. It is desired to absorb 98% of A present in the feed. Determine the equation of the operating line and the overall gas phase driving force at a point in the column where the bulk liquid concentration is $x_A = 0.04$.

(All the terms carry their usual meaning)

} }

Q. No. CH - 504 / 074

B. Tech./Odd
2016-17/Reg

2016-17

MECHANICAL OPERATIONS

CH - 504

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer should be brief and to the point;
All part of the same question to be answered in one place.

Group - A (35 Marks)

Answer question 1 and any two from the rest in the Group.

1. (i) Distinguish between Classification and Clarification.
- (ii) What should be the properties of a good filter medium.

2½×2

Or,

The power consumption in Agitated Vessels is dependent on several variables such as Rotational speed (n), Agitator diameter (D_a), Density of liquid (ρ), Acceleration due to gravity (g) and Viscosity of liquid (μ). With the help of Dimensional Analysis, show that the Power Number (P_0) is a function of Froude Number (F_r) and Reynolds Number (R_e).

5

(2)

2. (a) From the known expression of terminal settling velocity (v_t) for a spherical particle both in laminar and turbulent flow regions, derive the expression as well as values of K-factor for both the regions of flow. Why do we need to find K-factor ?
- (b) A mixture of 'silica' and 'galena' crushed particles ranging in size from 0.04 mm to 4.00 mm is separated by a rising stream of water.
Data: Density of galena, silica and water are 7.5, 2.65 and 1.0 gm/cm³ respectively. Viscosity of water is 0.01 poise.
- What velocity of water flow will give an uncontaminated product galena ?
 - What are sizing range of pure galena, pure silica and mixed products ?
 - Derive the expression for 'terminal settling velocity' of a spherical particle in laminar region.
3. (a) With the help of a neat sketch, describe the method of classification by Elutriator classifier.
- (b) Draw the Relative Settling Velocity (v) vs. Time (t) diagram for settling of heavier and lighter particles of various size ranges and explain the various zones of jiggling, equal settling and terminal settling of particles.
- (c) With the help of a neat sketch, explain the operation of a 'Mineral Jig'.
4. (a) With a suitable sketch, describe the method of operation in a 'Rotary Drum Vacuum Filter'.

(3)

- (b) A Rotary Drum Vacuum Filter having 40% submergence of the drum in the slurry is to be used to filter a CaCO₃ slurry using a pressure drop of 60 KPa. The solid concentration in the slurry is 0.2 kg solid / kg slurry and the filter cake is such that the ratio of Wet cake to Dry cake is 1.9. Density and viscosity of filtrate are 970 kg/m³ and 0.88×10⁻³ Pa.s respectively.

Specific cake resistance α may be taken as $5 \times 10^9 \times (-\Delta P)^{0.3}$ where $(-\Delta P)$ is in Pa and α in m/kg.

- If the filter cycle time is 300s, calculate the filter area needed to filter 0.83 kg slurry/s.
- What are the advantages of using filter aids ? Why washing of filter cake is conducted after filtration?

6+5+4

Group - B

Answer part (a) or (b) in question no 5 and any two from the rest in Group - B.

5. (a) Deduce the expression for Rittinger's law and Kick's law of comminution from generalized form and discuss their respective applications and limitations.

5

Or;

- (b) Determine the surface mean diameter and square root mean diameter of an ore sample that has the following size distribution :

5

(4)

ISS mesh	Percentage retained
-480+340	3.4
-340+240	6.3
-240+160	8.1
-160+120	10.2
-120+85	16.5
-85+60	13.1
-60+40	10.1
-40+30	9.5
-30+20	7.0
-20+15	4.7
-15+10	3.1
-10+8	2.0
-8	6.0

(5)

operation, it is observed that the average proportion of oversize product: undersize was 2 : 1½ : 1. Calculate the effectiveness of the screener from the following data :

Screen Mesh	Mass fraction
-10+14	0.000356
-14+20	0.00373
-20+28	0.089
-28+35	0.186
-35+48	0.258
-48+65	0.281
-65+100	0.091
-100+150	0.062
-150+200	0.025

6. (a) Discuss the theory and operation of Jaw Crusher.

(b) What are the factors influencing the size of the product in Ball Mill ?

(c) Table salt is being fed to a vibrating screen at the rate of 300 lb/hr. The mesh fraction of the desired product is 48/65. A 48 mesh screen and a 65 mesh screen are therefore used (double deck), the feed being introduced on the 48 mesh screen. During the

6+3+6

7. (a) Discuss the following :

- (i) Open circuit and close circuit grinding
- (ii) Taggart's rule for crushing
- (iii) Bradford Breaker
- (b) With a suitable schematic explain the construction and working of a cone crusher.

(6)

(c) Why are agglomeration and granulation necessary in industries and how is granulation performed using pug mill ?

(d) What do you mean by 'Capacity' of a screen ? How is it expressed ? 6+4+3+2

8. (a) Deduce the expression that determines the specific surface of a group of irregular shaped particle.

(b) What are the aspects in terms of which a tube mill and a rod mill differ from a ball mill ?

(c) A grinder is to be used to handle 10 tons/hr of a siliceous ore (specific gravity = 2.65). The feed and product analyses are given below :

Screen Size, mm	Feed Mass Fraction	Product Mass Fraction
-3.327+2.362	0.143	0.0
-2.362+1.651	0.211	0.0
-1.651+1.168	0.230	0.0
-1.168+0.833	0.186	0.098
-0.833+0.589	0.120	0.234
-0.589+0.417	0.076	0.277
-0.417+0.295	0.30	0.149
-0.295+0.208	0.0	0.101
-0.208+0.147	0.0	0.068
-0.147+0.104	0.0	0.044
-0.104	0.0	0.029

Estimate power consumption for grinding, if the work index of the ore is 13.57 kWh/ton. 4+4+7

2016-17

UNIT OPERATIONS OF CHEMICAL ENGINEERING II

CH - 531

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions taking at least *two* from each group.

Section - A

1. (a) What is diffusion? Explain how diffusion is affected by temperature and pressure.
- (b) Deduce a relationship of diffusion of one component through non-diffusing other component.
- (c) A narrow vertical glass tube 4 mm Id and 60 mm long is filled with acetone upto a height of 12 mm from the top open end placed in a gentle current of air at 20°C. After 5 hr, the liquid level has dropped to 21.5 mm from the top. The total pressure is $1.013 \times 10^5 \text{ N/m}^2$. At 20°C, the vapour pressure of acetone is 180 mm Hg and the density of liquid acetone is 790 kg/m^3 . Calculate the diffusivity of acetone in air at 20°C and $1.013 \times 10^5 \text{ N/m}^2$.

2. (a) Define 'Colburn - Drew mass transfer coefficient'.

 $4+4+6$

(2)

(b) State the physical significance of

- (i) Sherwood Number
- (ii) Schmidt Number

(c) The gas-phase reaction $A \rightarrow B$ occurs on the surface of a catalyst in the form of a wire gauge. The bulk concentration of the species A is 0.002 kmol/m^3 and the rate of reaction of A is measured at 0.12 kmol per hour per m^2 area of the catalyst. If the reaction is instantaneous and the entire diffusional resistance to the transport of the reactive species from the bulk gas to the catalyst surface is offered by a stagnant film of the gas, calculate (i) the thickness of the film; (ii) the mass transfer coefficients k'_G and k'_Y . Given : total pressure = 1.5 bar ; temperature = 250°C ; $D_{AB} = 0.16 \text{ cm}^2/\text{s}$ at 1 bar and 100°C .

3. (a) 'The absorption of less soluble gas is liquid phase resistance controlled' — Deduce the suitable equation and justify the statement.

(b) The equilibrium relation for a system is $y = 2.5x$. If the equilibrium relation is expressed in the form $Y = f(X)$, (X and Y are the concentrations in liquid and gas phases in the mole ratio unit) what would be the slope of this equilibrium line at $X=0$ and $X=0.1$?

(c) Deduce a relation of N_{tOG} for packed tower absorber.

4. (a) Define equilibrium moisture and free moisture.

(3)

(b) Discuss on different adsorption isotherm models.

(c) The overall gas phase mass transfer coefficient in an absorption tower is $K_y = 5.35 \text{ kmol/ (h)}(\text{m}^2)(\Delta y)$ and 70% of the total mass transfer resistance is known to be in the gas phase. The equilibrium relation is given by, $y = 3.2x$

The total pressure is 760 mm Hg. Calculate (i) the individual gas phase and liquid phase mass transfer coefficients ; (ii) the overall liquid phase mass transfer coefficient K_x

Section - B

5. (a) Write short notes on the following evaporators :

- (i) Long tube vertical
- (ii) falling film

(b) A feed of 4535 kg/hr of a 2% by wt. solution at 311°K enters continuously in a single effect evaporator and is being concentrated to 3% by wt. The evaporation is at atmospheric pressure and the area of the evaporator is 69.7 m^2 . Saturated steam at 383.2°K is supplied for heating. Since the solution is dilute, it can be assumed to have the same boiling point as water. The heat capacity of the feed can be taken as $C_p=4.1 \text{ kJ/kg. }^\circ\text{K}$. Calculate the amounts of vapor and liquid product and the overall heat transfer coefficient, U. (Assume latent heat of the steam at 383.2°K and given pressure is 2230 kJ/kg).

6+8

P.T.O.

(4)

6. A total feed of 200 mol/hr having an overall composition of 42 mol% heptane and 58 mol% ethyl benzene is to be fractionated at 101.3 kPa pressure to give a distillate containing 97 mol% heptane and a bottoms containing 1.1 mol % heptane. The feed enters the tower partially vaporized so that 40 mol% is liquid and 60 mol% vapor. Calculate the following :

(i) Moles per hour distillate and bottom

(ii) Minimum reflux ratio

(iii) Number of theoretical trays at total reflux

(iv) Theoretical number of trays required for an operating reflux ratio of 2.5:1. The equilibrium data as given :

Acetic acid	Water Layer (wt%)			Isopropyl Ether Layer (wt%)		
	water	Isopropyl Ether	Acetic acid	water	Isopropyl Ether	Acetic acid
0.0	98.8	1.2	0.0	0.6	99.4	
0.69	98.1	1.2	0.18	0.5	99.3	
1.41	97.1	1.5	0.37	0.7	98.9	
2.89	95.5	1.6	0.79	0.8	98.4	
6.42	91.7	1.9	1.93	1.0	97.1	
13.3	84.4	2.3	4.82	1.9	93.3	
25.5	71.1	3.4	11.4	3.9	84.7	
36.7	58.9	4.4	21.6	6.9	71.5	
44.3	45.1	10.6	31.1	10.8	58.1	
46.4	37.1	16.5	36.2	15.1	48.7	

14 14 14

8. Explain or discuss on the following :

- (a) Adiabatic saturation temperature
- (b) Minimum and maximum boiling azeotrope.
- (c) Differential Distillation
- (d) Tie line and plait point

x_H , Mole fraction of heptane	0.0	0.08	0.25	0.485	0.79	1.0
y_H , Mole fraction of heptane	0.0	0.23	0.514	0.73	0.904	1.0

7. An aqueous feed of 200 kg/hr containing 25 wt% acetic acid is being extracted by pure isopropyl ether at the rate of 600 kg/hr in a counter-current multistage system. The exit acid concentration in the aqueous phase is to contain 3 wt% acetic acid. Calculate
- (i) composition and amounts of the exit extract and raffinate streams
 - (ii) number of theoretical stages required. Use equilibrium data as given below:

2016-17

FUELS AND COMBUSTION

CH - 540

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions taking at least *one* but not more than *two* from each group.

Answer should be brief and to the point.

Group - A

1. (a) Define petroleum or crude oil. What is the difference between sweet and sour crude ? Write down the % amount of hydrocarbon in crude oil.
- (b) What do you mean by kerogen ? How it is related with origin of petroleum ?
- (c) Define U.O.P. characterization factor (K) of crude oil. How crude oil is categorized on the basis of K values ?

4+6+4

2. Write short notes :

- (a) Flash point and Fire point
- (b) Aniline point
- (c) Cetane number

5+5+4

P.T.O.

(2)

3. (a) What is the basic difference between TBP distillation and ASTM distillation ? Why sulfur removal is needed from crude oil ?

(b) What are the benefits of crude oil desalting process ?
Describe about desalting process.

(c) Briefly explain the catalytic cracking process. 2+6+6

Group - B

4. (a) State the name of different major units in the modern refinery.

(b) Briefly describe about coal liquefaction process for the generation of liquid fuel.

(c) What do you mean by liquid synthetic fuel ? Describe the Fischer-Tropsch process for the production of synthetic fuel. 2+6+6

5. (a) Mention the advantages and disadvantages of gaseous fuel. Classify the fuel gases based on the mode of occurrence and the method of production.

(b) Define calorific value for gaseous fuel.

(c) Describe the Lurgi process for the gasification of coal with a neat sketch. 5+2+7

6. (a) Define wobbe number. How fuel is classified based on wobbe number ?

(b) Compare CNG and LNG as gaseous fuel.

(c) Describe the Kopper-Totzek process for the gasification of coal with a neat sketch. 3+4+7

(3)

Group - C

7. (a) What are the different types of mineral matters present in coal ? How is coal ash related with the mineral matters ?

(b) How are 'moisture', 'ash' and 'volatile matter' contents of a coal sample determined in the laboratory ? 5+9

8. (a) Distinguish between the low temperature and high temperature carbonization of coal.

(b) Describe the modern by product coke oven plant for the production of metallurgical coke explaining the process of coking. 5+9

9. (a) What is weathering of coal ? What properties of coal are affected by it ?

(b) With the help of a neat sketch, explain how a Baum Jig operates.

Q. No. CS - 501 / 121

B. Tech./Odd
2016-17/Reg

2016-17

DATABASE MANAGEMENT SYSTEM (DBMS)

CS - 501

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any **five** questions from the followings :

1. (a) Consider the following set of requirements for an university database that is used to keep track of student's transcripts.
 - The university keeps track of each student's name, roll no, registration no, current address and phone, permanent address and phone, birthdate, sex, department and degree (B.Sc, B.Tech, M.Tech). Some user applications need to refer city, state and pin code of the student's permanent address. Both roll no and registration no have unique values for each student.
 - Each course has a course no, year, semester, instructor(s) timings and classroom and offering department.
 - Each instructor has id no, name, department and title, id no has unique value.
 - Each department is described by a name, departmental code, and office phone no.

(2)

Construct an ER diagram for this application. Write all assumptions that you make about the mapping constraints.

- (b) Explain the concept of specialization and generalization with an example.
- (c) Explain the term "foreign key" with the help of an example and highlight its importance in the design of database. 8+3+3

2. (a) Discuss the problems that may arise when one attempts to update a view.

- (b) Specify the following views in SQL on the COMPANY database shown in below.

EMPLOYEE (Name, SSN, DOB, Address, Sex, Salary, Dept. Number)

DEPARTMENT (Dept. Name, Dept. Number, Manager Name, Manager SSN, Manager Start Date)

DEPARTMENT LOCATIONS (Dept. Number, Dept. Location)

PROJECT (Project Name, Project Number, Project Location, Dept. Number)

WORKS ON (SSN, Phone Number, Hours)

DEPENDENT (SSN, Sex, DOB, Relationship)

- (i) A view that has the dept. name, manager name, and manager salary for every department.

- (ii) A view that has the employee name, supervisor name, and employee salary for each employee who works in the 'Research' department.

(3)

(iii) A view that has project name, controlling department name, number of employees, and total hours worked per week on the project for each project. 2+(3×4)

- (iv) A view that has project name, controlling department name, number of employees, and total hours worked per week on the project for each project with more than one employee working on it.
3. (a) One of the following four expressions of relational algebra is not equivalent to other three. They are all based on the relations R (A, B) and S (B, C). Indicate which is not equivalent to others. Explanation is needed.

$$\text{(i)} \quad \Pi_{A,B}(R \bowtie S)$$

$$\text{(ii)} \quad (R \bowtie \Pi_B)(S)$$

$$\text{(iii)} \quad R \cap (\Pi_A(R) \times \Pi_B(S))$$

$$\text{(iv)} \quad \Pi_{A,R,B}(R \times S)$$

- (b) Draw initial query tree for the following query and also optimize this query tree. Show each step clearly.

PJ EMPNAME((EMP JN DEPTNUM=DEPTNUM
SL MGRNUM=373 DEPT) DF
(SL SAL>35000 EMP JN DEPTNUM=DEPTNUM
SL MGRNUM=373 DEPT))

P.T.O.

(4)

- (c) Why we use the concept of a B tree? How it is different from B+ tree?
4. (a) Why is 3NF more preferable than BCNF in certain cases? Justify the following statement—"If the table contains only one candidate key, 3NF and BCNF are equivalent".

(b) Consider the relation R, which has the attributes that hold schedules of courses and sections at a University, $R = \{Course\ No., Sec\ No., Offering\ Dept., Semester, Year, Days\text{-}Hours, Room\ No., No.\ of\ Students, Credit\text{-}Hours, Course\ Level, Instructor\ SSN\}$. Suppose that the following functional dependencies hold on R:

$\{Course\ No.\} \rightarrow \{Offering\ Dept., Credit\text{-}Hours, Course\ Level\}$

$\{Course\ No., Sec\ No., Semester, Year\} \rightarrow \{Days\text{-}Hours, Room\ No., No.\ of\ Students, Instructor\ SSN\}$ and $\{Days\text{-}Hours, Room\ No., Semester, Year\} \rightarrow \{Instructor\ SSN, Course\ No., Sec\ No.\}$

Determine the key of R. How would you normalize this relation?

- (c) Suppose that we decompose the schema $R = (A, B, C, D, E)$ into $R_1 = (A, B, C)$ and $R_2 = (A, D, E)$. Show that this decomposition is lossless join decomposition if the following set F of FDs holds :

$$A \rightarrow BC, CD \rightarrow E, B \rightarrow D \text{ and } E \rightarrow A \\ (2+2)+6+4$$

(5)

5. (a) Discuss in brief the ACID properties of a transaction. State the difference between serial and serializable schedule with appropriate example. When two operations are said to be conflict?
(b) What is recoverable schedule? Why is recoverability of schedules desirable? Are there any circumstances under which it would be desirable to allow non recoverable schedule? Explain your answer.
(4+3+1)+(2+2+2)
6. (a) Show that two-phase locking protocol ensures conflict serializability, and that transaction can be serialized according to their lock points.
(b) What is cascading rollback? When a transaction is rolled back under timestamp ordering, it is assigned a new timestamp. Why can it not simply keep its' old timestamp?
(c) Compare the deferred-and-immediate modification versions of the log based recovery schemes, in terms of ease of implementation and overhead cost.
5+(2+3)+4
7. Write short notes on any two from the following :
(a) PJNF,
(b) Distributed Database
(c) Timestamp

Q. No. CS - 502 / 122

**B. Tech./Odd
2016-17/Reg**

2016-17

COMPUTER ORGANISATION AND ARCHITECTURE

CS - 502

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions.

Subparts of a question must be attempted together and in order.

1. (a) Explain the use of 0-address instructions with a stack-based organization of a CPU.
 - (b) Explain the main memory management of a stack based CPU. Particularly, explain the functions of the stack-base, stack-limit and stack-pointer registers.
 - (c) Explain how a register file may be used to speed up operations in a stack based CPU.
 - (d) Explain the following addressing modes with examples from the instruction set of 8085 (i) Indirect addressing mode (ii) Implicit addressing mode.
- 3+4+3+4
2. (a) What is a sequential ALU? Explain with a block diagram.
 - (b) Explain temporal expansion of an ALU. Discuss its advantages and disadvantages.

P.T.O.

(2)

- (c) Explain the concept and reason for biased exponents in the IEEE754 formats for representing floating point numbers. What is the bias of double precision numbers in IEEE754 ?

3. (a) Explain the organization of a 1-internal bus processor with the help of a diagram. Clearly show the direction for the interconnecting buses and I/O gating for all registers in the diagram.

- (b) For the processor organization given in (a), list the complete sequence of control signals, using the minimum number of timesteps, to execute the following 2-word instruction where the immediate argument is in the 2nd word of the instruction :

SUB RI, 07H (result in R1)

4. (a) Explain the principle of hardwired control in processor organization. Give a detailed block diagram of a hardwired control unit showing separate encoder and decoder blocks.

- (b) Show with a diagram how the Wait-for-MFC (WMFC) control signal may be generated from the MemRead, Mem Write and MFC signals.

- (c) Explain the advantages of a microprogrammed control unit over a hardwired control unit.

5. (a) What is memory interleaving and how does it speed up memory access?

- (b) Describe the principle of data storage on optical disks.

- (c) Explain the structure and function of a DRAM cell with a diagram.

(3)

6. (a) Explain the following :

- (i) I/O mapped I/O
(ii) Peripheral controlled I/O
(iii) Data Transfer with hand-shaking signals.
(b) Explain the difference between "cycle-stealing DMA" and "transparent DMA".

7. Write short notes on any four of the following :

- (a) Programmable Interrupt Controller
(b) Indexed Addressing Mode
(c) I/O Interface Bridge
(d) Flash Memory
(e) Channel Control Words (CCW)

$3\frac{1}{2} \times 4$

9+5

Q. No. CS - 503 / 120

**B. Tech./Odd
2016-17/Reg**

2016-17

COMPILER DESIGN

CS - 503

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answers should be brief and exactly to the point.
Answers of all the different parts of any question
should be written together.

Answer question number 1 and any *five* from the rest.

1. (A) Tick the wrong statement : $1 \times 5 = 5$

- (a) (i) To generate LL(1) Parsing table, the parser has to remove left recursion and need not perform left factoring of grammar rules.
- (ii) LL(1) parsing table can successfully parse all unambiguous sentence of an unambiguous grammar.
- (iii) If the grammar is ambiguous, then the LL(1) Parsing table should have all entries multiply defined.
- (iv) LL(1) parser scans the input sentences from left to right and produces leftmost derivation in forward.
- (b) (i) LR parser is not essentially a top down parser.

(2)

- (ii) If the grammar is unambiguous then an LR(k) parser with a particular value of k will be able to parse any sentence of the grammar.
- (iii) In LR(0) parser, shift reduce as well as reduce reduce conflict occurs in same state conflict occurs in different state.
- (v) LR(0) parser may encounter shift reduce and reduce conflict while LALR may encounter only reduce reduce conflict.
- (c) (i) The number of states in NFA is always greater than or equal to that of equivalent DFA
(ii) No DFA can never be further minimized.
(iii) The canonical collection of LR(0) items represents the states of the equivalent DFA Y .
(iv) An NFA can never be used in the design of lexical analyser.
- (d) (i) A reduced grammar is always an augmented grammar.
(ii) An augmented grammar is an equivalent grammar.
(iii) All equivalent grammars are necessarily reduced grammars.
(iv) An augmented grammar is essentially an equivalent grammar.
(e) (i) In the design of a language, context free grammar is invariably used.

(3)

- (ii) Context free grammar is one particular type of context sensitive grammar.
- (iii) A reduced grammar can never be a context sensitive grammar.
- (iv) Virtual Machine is essentially a translator.
- (B) Fill up the blanks with appropriate word(s) : $1 \times 5 = 5$
- (i) Any bottom up parser is more _____ than any top down parser.
- (ii) Three address code _____ compiler generated temporary variables.
- (iii) JAVA compiler stops compilation by only producing _____
- (iv) Error handler can only detect and correct _____ error.
- (v) In any error recovery the overhead of recovery should be _____ -
- (C) Type Yes or No for the following statements : $1 \times 10 = 10$
- (i) LALR parser cannot resolve both shift reduce and reduce conflict.
- (ii) For the same grammar, LALR parser has more number of states than LR(0) parser.
- (iii) LR(0) parser can resolve both shift reduce and reduce reduce conflict.

(4)

- (iv) A reduced grammar is always an augmented grammar.
- (v) An equivalent grammar always produces the same language as the original grammar.
- (vi) A reduced grammar may sometimes have same number of production rules as the original grammar.
- (vii) An augmented grammar always has one more production and one more nonterminal than the original grammar.
- (viii) Three address code may not generate compiler generated temporary variables.
- (ix) Any virtual machine never produces .exe file.
- (x) JVM is platform independent.

2. (a) What are the advantages and disadvantages of virtual machine? Why they are called virtual machine ?
- (b) What are the different steps to load a compiler of a newly invented language in different machines ?
3. (a) What are the different drawbacks of ordinary top down parser ? How they are removed in LL(1) Parser ?
- (b) For the following grammar

$$\begin{aligned} S &\rightarrow CC \\ C &\rightarrow aC \mid b \end{aligned}$$

Find the FIRST and FOLLOW of all the grammar symbols. Find out the regular expression of the grammar.

(5)

4. (a) What is/are the consequence(s) of parsing an ambiguous sentence of an ambiguous grammar by the following parsers?
- (i) LL(0)
 - (ii) LR(0)
 - (iii) LALR

- (b) Present the format of the items of \overline{G}
 - (i) LR(0)
 - (ii) LR(1)
 - (iii) LR(K)
 - (iv) LALR

Why you need an augmented grammar for the construction of LR table ?

5. (a) How triple differs from all other intermediate codes?
- (b) Translate the following program segment into three address code :
- ```
while w<y or x<z
do
 if w = 3 then y = y+10
else
 while w <= z then w = w+20
```

( 6 )

6. (a) Differentiate between
- (i) Local Error and Global Error
  - (ii) Immediate Error and Delayed Error.
- (b) What are the different overheads of error recovery ?
- What is the justification of minimum distance error recovery ?
- 5+5
7. (a) What are the different actions associated with Symbol Table ? What are the different techniques to implement 'Logical Deletion' of symbols from table ?
- (b) When 'Collision Handling Routine' is called in Hash Table Organization? How the collision handling routine has to be designed ?
- 5+5
-

**Q. No. CS - 504 / 121**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**OPERATING SYSTEMS**

**CS - 504**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Attempt any five questions.

1. (a) State the algorithm executed by the wait system call.  
(b) Illustrate how a parent process can use wait to wait for (i) anyone of the child termination and (ii) for all of its child process termination.  
(c) State the significance of zombie and orphan process.
2. (a) Justify "The fair share scheduling is an implementation of multilevel feedback scheduling strategy".  
(b) State and explain fair-share scheduling. Illustrate how it ensures fairness across groups not just process.  
(c) Explain the use of nice value in user process scheduling.  
(d) How remaining execution time is estimated in short term scheduling strategies.

**5+5+4**

**2+7+2+3**

**P.T.O.**

( 2 )

3. (a) Write the difference between user level threads and kernel level threads.
- (b) State the functions used in POSIX thread library to create, join and exit threads. Explain the different arguments of the functions.
- (c) Define : response time, turnaround time, throughput.
4. (a) State Lampart Bakery algorithm. Can it ensure mutual exclusion ? Explain how.
- (b) Justify "Monitors are often preferred over semaphores".
- (c) State the producer consumer problem. Define semaphore. Provide a solution using semaphore for producer consumer problem.  $(4+2)+1+(2+1+4)$
5. (a) State the functioning of a memory management system which organizes a segments into a set of pages.  
(b) What is page fault ? State how LRU can be implemented. What is Belady's anomaly ?  
(c) Provide a solution for reader-writer problem using monitors.  $5+(1+3+1)+4$
6. (a) State how large files are stored in disk using the inode structure.  
(b) State different strategies how free space is handled in disk. Mention their drawbacks.  
(c) Write a program where a parent process creates two child process. First child process sleeps for a random time span and then exits. The parent sends a signal

( 3 )

to terminate the remaining child process on receipt of the death of child signal of 1st child.  $5+(2+2)+5$

7. Write short notes (any two):

- (a) Short term scheduling
- (b) FAT
- (c) Thrashing
- (d) Implementation of fork ()

7+7

Q. No. CS - 543 / 063

B. Tech./Odd  
2016-17/Reg

2016-17

**DATABASE MANAGEMENT SYSTEM (DBMS)**

CS - 543

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Answer question 1 from Group-A and any five from Group-B.

**Group-A**

1. Briefly describe the following : 5×5

- (a) Data Model,
- (b) Types of Keys used in database design,
- (c) Cartesian Product Vs. Natural Join,
- (d) Functional Dependency,
- (e) ACID Properties of a transaction.

**Group-B**

2. (a) Describe the three level architecture of DBMS. Discuss the term “Security” and “Integrity” of a database with the help of appropriate example. 3+3
- (b) Justify the following statement with example — “The primary key is possible for a weak entity set”. 3

( 2 )

3. (a) Explain with two examples why the set  $\{\sigma, \Pi, \cup, \neg, X\}$  is called the complete set of relational algebra operation.

- (b) Construct an E-R diagram for a standard hospital management system considering necessary assumptions.

4. (a) Consider the following relations for a company database.

Employee (Ename, SSN, Bdate, Address, Sex, Salary, SuperSSN, Dno)

Department (Dname, Dno, MgrSSN, Mgrstartdate)

Project (Pname, Pno, Plocation, Dno)

Works\_On (Essn, Pno, Hours)

Dependent (Essn, Dependent name, Sex, Bdate, Relationship)

Write the queries of the following in SQL.

- (i) Retrieve the names of all employees in department 5 who work more than 10 hours per week on the "Product X" project.

- (ii) List the names of all employees who have a dependent with the same first name as themselves.

- (iii) For each department, retrieve the department name, and average salary of all employees working in that department.

( 3 )

5. Consider a disk with block size  $B = 512$  bytes. A block pointer is  $P = 6$  bytes long and a record pointer is  $Pr = 7$  bytes long. A file has  $r = 30,000$  EMPLOYEE records of fixed length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), DEPARTMENT CODE (9 bytes), ADDRESS (40 bytes), PHONE (9 bytes), BIRTHDATE (8 bytes), SEX (1 byte), JOBCODE (4 bytes), SALARY (4 bytes). An additional byte is used as a deletion marker.

- (i) Calculate the record size  $R$  in bytes. 1  
(ii) Calculate the blocking factor (bfr) and the number of file blocks in B. 2  
(iii) Calculate the average time it takes to find a record by doing linear search on the file. 1  
(iv) Suppose the file is ordered by the key field SSN and we want to construct a primary index on SSN. Calculate the number of block accesses needed to search for the retrieval a record from the file. 2  
(v) Suppose the file is not ordered by the key field SSN and we want to construct a secondary index on SSN. Repeat the same (part iv) for the secondary index and compare it with the primary index. 3

6. (a) Explain the following terms "Fully functional dependency" and "Non-transitive dependency" with examples. 4  
(b) Consider a relation  $R(A, B, C, D, E)$  with the following functional dependencies:

$$AB \rightarrow C, CD \rightarrow E, DE \rightarrow B$$

P.T.O.

( 4 )

Is AB a candidate key of this relation? If not, is ABD? Explain your answer.

7. (a) Use Armstrong's axioms to prove the soundness of the decomposition rule.

3

(b) Consider the relation R, which has the attributes that hold schedules of courses and sections at a University,  $R = \{Course\ No., Sec\ No., Offering\ Dept., Semester, Year, Days-Hours, Room\ No., No.\ of\ Students, Credit-Hours, Course\ Level, Instructor\ SSN\}$ . Suppose that the following functional dependencies hold on R :

$\{Course\ No.\} \rightarrow \{Offering\ Dept., Credit-Hours, Course\ Level\}$

$\{Course\ No., Sec\ No., Semester, Year\} \rightarrow \{Days-Hours, Room\ No., No.\ of\ Students, Instructor\ SSN\}$  and  $\{Days-Hours, Room\ No., Semester, Year\} \rightarrow \{Instructor\ SSN, Course\ No., Sec\ No.\}$

Determine the key of R. How would you normalize this relation?

6

8. Explain the distinction between the terms serial schedule and serializable schedule. Discuss locking approaches to concurrency control.

4+5

**Q. No. EC - 501 / 105**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**DIGITAL COMMUNICATION**

**EC - 501**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

**Instructions :** (i) Answer at least *one* question from each group  
(ii) Answer total *five* questions all together

**Group - A**

1. (a) State the sampling theorem. Explain the ideal sampling process with necessary expressions and diagrams.
- (b) The signal  $g(t) = 10 \cos(20\pi t) \cos(200\pi t)$  is sampled at the rate of 250 samples per second.
  - (i) Determine the spectrum of the resulting sampled signal.
  - (ii) What is the Nyquist rate?
  - (c) Explain the process of quantization and obtain an expression for signal to quantization noise ratio in the case of a uniform quantizer.
  - (d) Describe delta modulation systems. What are its limitations ? How can these be averted ?

**$3+3+4+4=14$**

**PT.O.**

( 2 )

2. (a) What is TDM ? State the advantages and disadvantages of TDM.
- (b) Given a data stream 1100110001101011, sketch the transmitted pulse sequence for each of the following line codes :

Non-return to zero, Return to zero, Bipolar signaling, Manchester code, Differential encoding.

- (c) Explain how ISI occurs in base-band binary data transmission system. In this context also explain how to minimize this problem through pulse shaping.  
 $3+5+6=14$

#### Group - B

3. (a) The binary sequence 1110010001 is applied to a QPSK modulator. The bit duration is 1  $\mu$ sec. The carrier frequency is 6 MHz. Plot the waveform of the QPSK signal.

- (b) Discuss the coherent and noncoherent reception of binary FSK signal.

- (c) With block diagram discuss generation of 16-level QAM signal. Also discuss the bandwidth of the input and output of the QAM generator.  
 $2+6+6=14$

4. A single voice channel is to be transmitted via PCM techniques, using satellite communications. 8000 samples/s are taken, and 7-bit quantization (128-levels) is used. 32 synchronization bits are inserted into the binary stream for every 224 data bits transmitted. The resultant binary stream is then transmitted using sinusoidal roll-off shaping for each pulse. The roll-off factor is 20%.

( 3 )

- (a) What is PCM bit rate in bits/S ?
- (b) What is the baseband (PCM signal) bandwidth ?
- (c) PSK is used for transmission. What is the transmission bandwidth required ?

- (d) QPSK is used instead: successive pairs of bits are used to phase modulate a carrier. What is the transmission bandwidth required in this case ?  
 $4+3+3+4=14$
5. (a) Find the probability of error or BER for a binary transmission due to presence of white Gaussian noise, where NRZ unipolar signaling is used, that is, pulse level is either 0 or A. Assume occurrence of symbols 0s and 1s are equally likely.

- (b) (i) If in above case A be 1 volt in amplitude and rms noise voltage be 0.2 volt, what is the probability of error,  $P_e$  or BER.
- (ii) If the transmission rate be 50,000 bits/sec what is the average time between errors in this system ?  
 $8+6=14$

#### Group - C

6. (a) A sample function  $x(t)$  of a random process is applied to a linear filter with impulse response  $h(t)$ . Find out the mean square of output  $y(t)$  i.e.  $\overline{y^2(t)}$  and obtain

$$\overline{y^2(t)} \text{ for an input white noise.}$$

- (b) Answer either (i) or (ii)

- (i) A signal  $X(t) = A \cos(\omega_0 t + \theta)$  where  $\omega_0$  is a constant and  $\theta$  is a random variable uniformly

P.T.O.

( 4 )

distributed over  $(-\pi, \pi)$  is added with a noise  $N(t)$  in the channel and the received signal is  $Y(t)$ . If  $X(t)$  and  $N(t)$  are independent, show that auto correlation of  $Y(t)$  will be periodic.

- (ii) A random process  $Y(t) = X(t) + N(t)$ , where  $X(t) = A \cos(\omega_0 t + \Theta)$ ,  $\omega_0$  is a constant and  $\Theta$  is a random variable uniformly distributed over  $(-\pi, \pi)$  is added with a white noise  $N(t)$  of spectral density  $\frac{N_0}{2}$ . Derive the cross correlation between the output  $Y(t)$  and input  $X(t)$ .

- (c) Explain the following indicating their relation (i) Ergodic process (ii) Wide sense stationary process.

- (d) Let  $X(t)$  be a WSS random process with ACF  $R_{xx}(\tau) = e^{-\alpha|\tau|}$  where  $\alpha > 0$ .

We assume  $X(t)$  amplitude modulates a carrier  $\cos(\omega_0 t + \Theta)$  where  $\omega_0$  is a constant and  $\Theta$  is a random variable uniformly distributed over  $(-\pi, \pi)$  and statistically independent of  $X(t)$ . Find and plot the auto correlation function (acf) of the modulated signal  $Y(t)$ .

7. (a) Derive the impulse response of a filter matched to the signal  $s(t)$  in presence of white noise. Explain the relationship between matched filter and signal correlator.

( 5 )

- (b) State properties of a narrowband Gaussian noise. Derive and plot the envelope and phase for a narrowband Gaussian noise.

8. (a) State Shannon's Channel Capacity Theorem and Explain Shannon's limit with a necessary figure.
- (b) Define mathematically and explain (i) Mutual Information (ii) Conditional entropy.
- (c) Find the capacity of a binary symmetric channel with a flipping probability of ' $p$ ' and plot the capacity wrt ' $p$ '.

- (d) Prove that  $H(X|Y) \leq H(X)$ , under what condition does the equality hold?

9. (a) What is a prefix code? State and prove Source Coding theorem.
- (b) Define generator matrix, parity check matrix of a linear block code.

- Given the generator matrix ( $G$ ) as below, determine the parity check matrix  $H$  for (5, 3) code. Show that  $GH^T = 0$  and  $cH^T = 0$  for  $c = (11010)$

$$G = \begin{pmatrix} 1 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 \end{pmatrix}$$

- Calculate syndrome ( $S$ ) for any arbitrary message  $r = (r_0, r_1, r_2, \dots, r_4)$ .

**Q. No. EC - 503 / 106**

**B. Tech/Odd**  
**2016-17/Reg**

**2016-17**

**DIGITAL SIGNAL PROCESSING**

**EC - 503**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer any five questions.

1. (a) What is zero padding ? What are its uses ?
- (b) Find the DFT of a sequence  $x(n) = \{1, 1, 0, 0\}$  and the IDFT of  $y(k) = \{1, 0, 1, 0\}$
- (c) Find the DFT of a sequence

$$x(n) = 1 \text{ for } n \leq n \leq L \\ = 0 \text{ otherwise}$$

for  $N = 4$  plot /  $x(k)$  / and  $\angle x(k)$

- (d) What is a relation between Fourier series coefficients of a periodic sequence and DFT ?  
$$2+4+6+2$$
2. (a) State and prove time shifting property of DFT.
- (b) Obtain the 8-point circular convolution, of the following sequences :

$$x_1(n) = \{2, 3, 6, 8, 2, 1, 7, 5\} \\ x_2(n) = \{0, 0, 0, 0, 0, 1, 0, 0\}$$

( 2 )

- (c) Let  $H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$  represent the transfer function of a Lowpass filter with a passband of 1 rad/sec. Use frequency transformation to find the transfer functions for the following analog filters :

- (i) A lowpass filter with passband of 10 rad/sec.
- (ii) A highpass filter with cut off frequency of 10 rad/ $3+3+8$  sec.

3. (a) Obtain the cascade realization of the system function

$$H(z) = (1 + 2z^{-1} - z^{-2})(1 + z^{-1} - z^{-2})$$

- (b) Determine the direct form realization of the system function  $H(z) = 1 + 2z^{-1} - 3z^{-2} - 4z^{-3} + 5z^{-4}$ .

- (c) Find the impulse response of an FIR lattice filter with coefficients  $K_1 = 0.65$ ;  $K_2 = 0.34$ ;  $K_3 = 0.8$ .

- (d) Obtain the direct form - I and direct form - II structure for the filters given by system function

$$H(z) = \frac{1 + 0.4z^{-1}}{1 - 0.5z^{-1} + 0.06z^{-2}} \cdot \frac{2+2+4+6}{}$$

4. (a) Given the following  $x(n)$  :

$$x(n) = \delta(n) + \delta(n-1) + \delta(n-2)$$

- (i) Find the Fourier transform  $X(e^{j\omega})$  and plot the  $|X(e^{j\omega})|$ .

- ( 3 )
- (ii) Get the magnitude of the 4-point DFT of the first four samples of  $x(n)$ .
  - (iii) Get the magnitude of the 8-point DFT of the first eight samples of  $x(n)$ .

- (b) Find the 4-point DFT of the sequence

$$x(n) = 6 + \sin \frac{2\pi n}{4}; \quad 0 \leq n \leq 3$$

- (c) Consider the sequence  $x_1(n) = \begin{cases} 0, & n=0 \\ 1, & n=1, 2, 3 \\ 0, & n=4 \end{cases}$  and  $x_2(n) = \begin{cases} 0, & n=0, 1, 2 \\ 1, & n=3, 4 \\ 0, & n=5, 6 \end{cases}$ . Determine the sequence  $y(n)$  so that  $Y(k) = X_1(k)X_2(k)$ .  $X_1(k)$  and  $X_2(k)$  are 5-point DFT of  $x_1(n)$  and  $x_2(n)$  respectively.

5. (a) A sequence  $x(n) = \begin{cases} 1, & 0 \leq n \leq 3 \\ 0, & 4 \leq n \leq 7 \end{cases}$  has an 8-point DFT  $X(k)$ . Compute the DFT of  $x_2(n)$  and  $x_3(n)$  in terms of  $X(k)$  for

$$x_2(n) = \begin{cases} 1, & n=0 \\ 0, & 1 \leq n \leq 4 \\ 1, & 5 \leq n \leq 7 \\ 0, & 6 \leq n \leq 7 \end{cases}$$

P.T.O.

( 4 )

- (b) Consider a sequence  $x(n) = \{8, 3, 4, 1, -5, -4, -2, 0, 2, -1, 7, 4\}$ . Evaluate the following without explicitly computing  $X(k)$ .

i)  $\text{DFT}[\text{DFT}[\text{DFT}[x(n)]]]$

ii)  $\sum_{k=0}^{11} X(k)$

iii)  $\sum_{k=0}^{6+8} e^{-j\frac{\pi k}{6}} X(k)$

6. (a) Obtain the series and parallel form realization for a digital filter described by the system function,

$$H(z) = \frac{8z^3 - 4z^2 + 11z - 2}{\left(z - \frac{1}{4}\right)\left(z^2 - z + \frac{1}{2}\right)}$$

- (b) Determine the parameters  $k_m$  of the lattice filter corresponding to the FIR filter design described by,

$$H(z) = 1 + 2.82z^{-1} + 3.408z^{-2} + 1.74z^{-3}, \quad 8+6$$

7. (a) Design a Chebyshev and Butterworth filter to meet the following specifications :

- (i) Passband ripple  $\leq 2 dB$
- (ii) Stopband attenuation  $\geq 20 dB$
- (iii) Passband edge : 1 rad/sec
- (iv) Stopband edge : 1.3 rad/sec.

( 5 )

8. (a) Realize FIR linear phase filter for N to be even.

- (b) Explain the term All pass complementary and power complementary filter with suitable example.
- (c) Justify the statement "First order IIR LPF and HPF are All Pass as well as Power Complementary."

4+6+4

9. (a) For the desired frequency response

$$H_d(w) = \begin{cases} e^{-j/3w}; & -\frac{3\pi}{4} < w < \frac{3\pi}{4} \\ 0; & \frac{3\pi}{4} < |w| < \pi \end{cases}$$

find  $H(w)$  for  $N=7$  using Hamming window.

- (b) Show that for  $\beta=0$ , Kaiser window becomes a rectangular window.
- (c) Mention few advantages and disadvantages of windowing technique.

8+3+3

7+7

**Q. No. EC - 504 / 108**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**COMPUTER ARCHITECTURE & ORGANIZATION**

**EC - 504**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Attempt any five questions.

1. (a) Explain 32 bit multiplication algorithm with suitable block diagram.
- (b) Suppose we have two implementations of the same instruction set architecture. Computer A has a clock cycle time of 250 ps and a CPI of 2.0 for some program. Computer B has a clock cycle time of 500 ps and a CPI of 1.2 for the same program. Which computer is faster for this program and by how much ?
- (c) Explain Register file with suitable block diagram.

$$5+4+5=14$$

2. (a) A computer has to perform a task. The task has six instructions. Each one of the first three instructions needs 6T states for Execute cycle. Each one of the remaining instructions needs 4T states for Execute cycle. Each Fetch cycle needs 3T states. Determine the time needed to complete the task if the clock frequency is 1 GHz.

( 2 )

- (b) Given the 16 bit value 1001101011001101 what must be performed in order to

- (i) Clear to '0' the 1<sup>st</sup> 8 bits ?
- (ii) Set to '1' the last 8 bits ?
- (iii) Complement the middle 8 bits ?

- (c) A memory unit of computer has 256k words of 32 bits each. The computer has an instruction format with four fields; an operation code field, a mode field to specify one of seven addressing modes, a register address field to specify one of 60 processor registers, and a memory address field. Specify the instruction format and the number of bits in each field if each instruction is in one memory word.
- $$6+3+5=14$$

3. (a) A 36 bit floating point binary number has 9 bits plus sign for the exponent. The co-efficient is assumed to be a normalized fraction. The numbers in the co-efficient and exponent are in sign magnitude form. What are the largest and smallest positive quantities that can be accommodated, excluding zero ? Determine the range. What is overflow and underflow ?

- (b) Consider a 16 bit floating point number in a format (similar to XS-127 IEEE 754) with a 6 bit exponent and a 9 bit normalized fractional mantissa. The base of the scale factor is 2 and the exponent is represented in XS-31 format.

Add the numbers A and B, formatted as follows :

$$A=0 \ 100001 \ 11111110$$

$$B=0 \ 011111 \ 001010101$$

$$7+7=14$$

( 3 )

4. (a) Define the following terms: (i) write through protocol, (ii) valid bit, (iii) TLB, (iv) write back protocol.

- (b) Design an arithmetic circuit with selection input variables S1 and S0 that generates the following arithmetic operations. Draw the logic diagram of one typical stage.

| S1 | S0 | Cin=0   | Cin=1   |
|----|----|---------|---------|
| 0  | 0  | F=A     | F=A+1   |
| 0  | 1  | F=A-B-1 | F=A-B   |
| 1  | 0  | F=B-A-1 | F=B-A   |
| 1  | 1  | F=A+B   | F=A+B+1 |

$$4+10=14$$

5. Design hardware control unit for a computer with STA and LDA instructions.

6. (a) Draw and explain the block diagram of  $2^2 \times 1$  bit organized memory constructed using SRAM. Show the complete diagram. How is this memory interfaced with CPU ?

- (b) What is meant by locality of reference ? Explain in detail. A computer has a cache access time  $T_c = 8\text{ ns}$  and a physical memory access time  $T_m = 65\text{ ns}$ . If the hit ratio is 75% what is the total average access time ? Show intermediate steps.

- (c) Explain set associative mapping with suitable block diagram.

$$6+4+4=14$$

P.T.O.

( 4 )

7. What is an interface module ? Explain the functioning of any one of the commonly used interface module. Write down the sequence of micro-operations required for interrupt cycle. Explain pipeline processing with the help of space-time diagram.  
 $2+3+4+5=14$

8. Write short notes on any *two* of the following :  $7 \times 2 = 14$

- (a) Evolution of computer
  - (b) Virtual memory
  - (c) Microprogrammed control
  - (d) DMA
-

**Q. No. EC - 541 /**

**0'70**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**SOFT COMPUTING**

**EC - 541**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Attempt any *five* questions.

1. Describe in details the various steps involved in optimizing a function using Backtracking search algorithm. 14
2. Explain in details the various steps involved in optimizing a function using Quantum Particle swarm optimization (QPSO) algorithm. 14
3. Discuss in details the various steps involved in optimizing a function using Gravitational search algorithm. 14
4. Explain the following terms in connection to Genetic algorithm :
  - (a) Non-linear ranking selection
  - (b) Non-uniform mutation
  - (c) Heuristic crossover.
5. Discuss in details the various steps involved in optimizing a function using Fire fly algorithm. 14

**7+4+3**

**P.T.O.**

( 2 )

6. Explain in details with diagram the Back propagation algorithm for training a multi layer artificial neural network. 14
7. Explain in details with diagram the theory of radial basis function neural network. 14
8. Describe in details the various steps involved in optimizing a function using Teaching learning based optimization (TLBO) algorithm. 14

**Q. No. EC - 502 /      1 0<sup>7</sup>**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**INTRODUCTION TO VLSI**

**EC - 502**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

**Answer any five questions.**

1. (a) Define Threshold voltage of MOSFET. Write down the square law equation of n-channel MOSFET and P-channel MOSFET. Draw the V-I characteristics of N-channel and P-channel MOSFETS. What are the three regions of operation of a MOS transistor?  
**(b)** Derive the expression of threshold voltage of an n-channel MOSFET.  
**2+2+2+2+6**
2. (a) Discuss the effect of Full scaling(constant-Field scaling) and constant voltage scaling on :  
**(i) Cox**  
**(ii) ID**  
**(iii) P**  
**(iv) Power Density**

**P.T.O.**

( 2 )

- (b) Explain the following :
- Channel length modulation of MOSFET. How the voltage current characteristics are affected because of this effect?
  - Substrate bias effect or Back Gate affects of MOS transistors.
  - Draw the schematic of CMOS. Explain the operation of CMOS inverter. Write down the advantages of CMOS. Draw the VTC curve for CMOS inverter. Derive the expression for logic threshold voltage or mid-point voltage of CMOS inverter. Derive the total power dissipation of CMOS inverter.

- What is scaling of MOS devices? Write down the advantages and disadvantages of scaling of MOSFET. Compare between constant voltage scaling and constant E-field scaling.

- Consider an NFET process that uses an n-type poly gate. The important processing parameters are as follows :

$$t_{ox} = 500 \text{ Å}, N_A = 10^{15} \text{ cm}^{-3}, \mu_n = 580 \text{ cm}^2/\text{V}\cdot\text{sec}, V_{Ton} = 0.7 \text{ V}$$

- Calculate the value of the oxide capacitance per unit area  $C_{ox}$ . Place your answer in units of  $\text{F}/\text{cm}^2$  and  $\text{fF}/\mu\text{m}^2$ .

- Find the value of  $k_n$  in units of  $\mu\text{A}/\text{V}^2$ .

( 3 )

- Find the value of the body-bias co-efficient  $\gamma$ . Plot  $V_{Tn}$  as a function of the source-bulk voltage  $V_{SB} = 0$  to 5 volts.
- Suppose that an NFET is made with  $W = 10 \mu\text{m}$  and  $L = 1 \mu\text{m}$ . Voltages of  $V_{GSh} = 2.5 \text{ V}$ ,  $V_{DSn} = 2 \text{ V}$  and  $V_{SB} = 1.25 \text{ V}$  are applied. Calculate the drain current using the square law equations.
- Repeat the calculation in (iv) if the  $V_{DSn} = 4 \text{ V}$ .
- What is constant voltage scaling? How delay time, power density and power dissipation are affected in a device scaled with constant voltage scaling ?

$1+2+3+2+2+4$

- What is short channel effect? Explain the followings
  - Drain-induced barrier lowering and punch-through
  - surface scattering
  - velocity saturation
  - impact ionization
  - hot electrons.
- (a) What is short channel effect? Explain the followings
  - Drain-induced barrier lowering and punch-through
  - surface scattering
  - velocity saturation
  - impact ionization
  - hot electrons.

$1+2+3+2+4$

$$\begin{aligned} f_{ox} &= 2 \times 10^{10} \text{ cm}^{-3}, \text{ Take } \varepsilon_0 = 8.85 \times 10^{-14} \text{ F/cm}, \\ \varepsilon_{si} &= 11.7 \times \varepsilon_0 \text{ F/cm}, \varepsilon_{ox} = 3.97 \times \varepsilon_0 \text{ F/cm}. \end{aligned}$$

P.T.O.

( 4 )

7. (a) What are parasitic capacitances in the MOS devices?  
Write down the effects of parasitic capacitances on  
MOS devices. Define with an example : SSI, LSI,  
MSI and ULSI.

(b) Why do the present VLSI circuits use MOSFETs  
instead of BJTs? Give the Cross-sectional diagram of  
the CMOS. Define term VLSI. Write down the  
advantages and application of VLSI.

$$(2+2+3)+(2+1+1+3)$$

8. Analytically derive and justify the fact that NMOS is strong  
for logic 0 transfer, weak for logic 1 transfer; whereas  
PMOS has the opposite characteristics.

7+7

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**Q. No. EE - 501 / 104**

**B. Tech/Odd**  
**2016-17/Reg**

**2016-17**

**ELECTRICAL MACHINES - II**

**EE - 501**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

All question of a Group should be answered at one place and to the point.

**Group - A**

(Answer all)

**2x7**

1. (a) Why distributed winding is used in ac machines?
- (b) Which method yields a pessimistic voltage regulation in an alternator and why?
- (c) When do circulating currents flow through the alternators connected in parallel?
- (d) What is the speed regulation of a synchronous motor and why?
- (e) What is synchronizing power?
- (f) Why a starter is necessary to start an induction motor?
- (g) What do you mean by split phasing?

( 2 )

### Group - B

2. Answer any four : 6×4

- (a) Describe the method of determining the regulation of an alternator by ampere-turn method.
- (b) Based on Blondel's two-reaction theory develop the phasor diagram of a salient pole synchronous generator.

- (c) What is the necessity for paralleling alternators? State the conditions to be fulfilled before connecting an alternator with the infinite bus.
- (d) Explain the circle diagram of a synchronous motor for constant power developed and variable excitation.
- (e) Discuss the procedures of no-load and blocked rotor test on 3 phase induction motor. Draw approximate equivalent circuit for each condition.
- (f) Explain any two methods by which speed of an induction machine be varied.
- Ans. digraph
- Group - C**
3. Answer any four : 8×4
- (a) The flux distribution curve of a smooth-core, 50 Hz generator is  $B = \sin \theta + 0.25 \sin 3\theta + 0.15 \sin 7\theta \text{ T}$ , when  $\theta$  is measured from the neutral axis. The pole pitch is 35 cm, the core length 32 cm, and the stator coil span four-fifth of the pole pitch. Determine the equation for the emf induced in one turn, and its rms value.

( 3 )

- (b) A 250 kVA, 3.3 kV, 50 Hz, 3 ph synchronous generator is star connected. The effective armature resistance is  $5\Omega / \text{phase}$  and the synchronous reactance is  $30\Omega / \text{phase}$ . Calculate the voltage regulation at full load (i) 0.7 power factor lagging and (ii) 0.8 power factor leading.
- (c) A 440 V, 50 Hz, three-phase, star connected synchronous motor has a synchronous reactance of  $8\Omega$  per phase and negligible armature resistance. When the motor runs at a speed of 1500 rpm, it consumes 8 kW and the excitation voltage is 530 V. Determine (i) power angle, (ii) power factor, (iii) current and (iv) torque developed by the motor.
- (d) A 3 phase induction motor has a 4 pole, star connected stator winding. The motor runs on 50 Hz supply with 230 V between lines. The rotor resistance and standstill reactance per phase are  $0.1\Omega$  and  $0.9\Omega$  respectively. The ratio of rotor to stator turns is 0.6. Calculate (i) the torque at 4% slip, (ii) maximum torque, and (iii) speed at maximum torque.
- (e) A 3-phase, 500 V, 50 Hz induction motor with 6 poles develops 25 HP at 950 rpm with a pf of 0.86. The mechanical losses total 1 HP. Calculate (i) the slip, (ii) rotor cu-loss, (iii) the input if the stator cu-losses total 1500 W and (iv) the line current.

**Q. No. EE - 502 / 105**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**POWER SYSTEMS - II**

**EE - 502**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

All parts of a question should be answered at one place in sequence.

Answer any *five* questions.

1. (a) Why are series reactors used in power systems? Show different schemes of connections of series reactors. 5
- (b) One small power station has two generators  $G_1$  and  $G_2$ , rated at 11kV, 10MVA each, with reactances of 5% and 10% respectively are connected to a common busbar, as shown in the figure 1. The circuit breakers are rated at 350MVA. The system is expanded by connection to the grid through a transformer T of 10 MVA and 7.5% reactance, due to increased load. Find the reactance necessary to protect the circuit breakers.

( 2 )

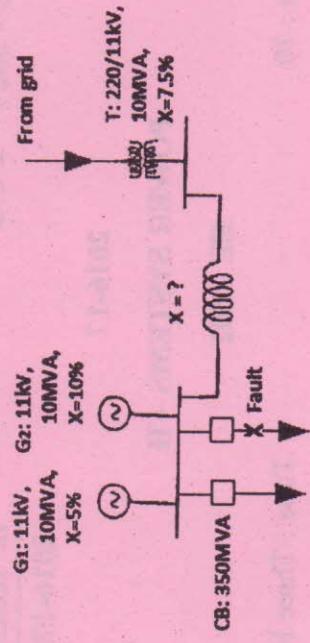


Figure 1

2. A single line to ground fault has occurred at the receiving end of the system given in figure 2. The ratings of different elements are as given in the figure. Neglect the pre-fault current and calculate the sub-transient fault current.

( 3 )

3. (a) With the help of suitable diagram illustrate primary relaying of a typical power system. 4

- (b) Explain remote back-up and relay back-up schemes. 6

- (c) Develop the expression of operating torque of induction type relays. 4

4. (a) What is the difference between a substation and a switching station? Show possible schemes of switching station for two incoming and two outgoing lines. 5

- (b) Show schematic layout of a typical receiving end substation with two 220kV incoming lines and three 33kV outgoing lines. Keep provision for substation auxiliaries. 4

- (c) With the help of suitable diagram discuss in brief the unit type connection of generators. 5

5. (a) Explain in brief necessity of directional relays for protection of parallel feeders. 2

- (b) Draw voltage and current phasors for different types of connections of directional relays. 5

- (c) Draw vector diagram of directional relay and indicate the operating zone of the relay. 3

- (d) What are "Plug Setting Multiplier" and "Time Multiplier Setting" of over current relays? 4

6. (a) With the help of suitable connection diagram explain in short biased differential protection of three phase Y/Y connected power transformers. 5

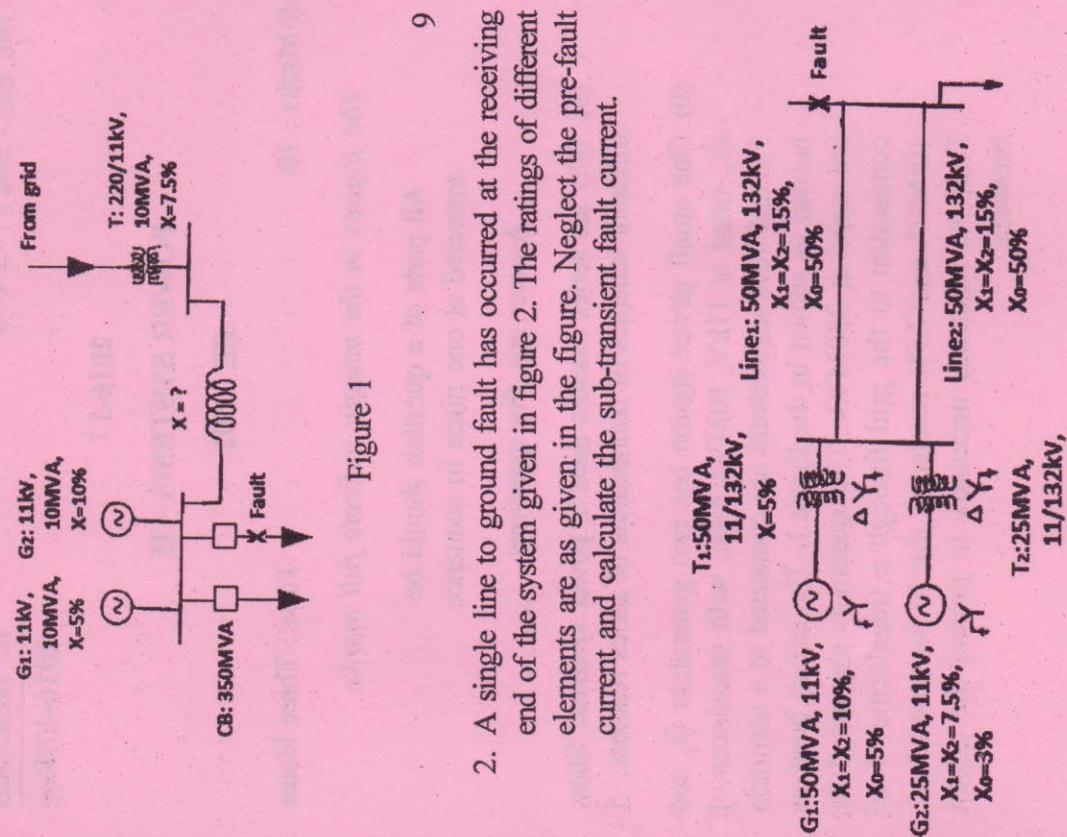


Figure 2

14

( 4 )

- (b) Show the scheme of restricted earth fault protection for the transformer of question 6(a). 4
- (c) What is "Buchholz" relay? Explain in brief its working principle. 5
7. (a) Show that the characteristic of a plain impedance relay on R-X plane is a circle. 4
- (b) What is under-reach of impedance type of relay? How is it avoided? 4
- (c) Explain the carrier current protection of transmission lines. 6
8. With the help of necessary diagrams briefly explain protection of a star connected generator against : 6
- (a) phase to phase fault,
- (b) stator earth fault and 4
- (c) rotor earth fault. 4
-

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Q. No. EE - 503 /

B. Tech./Odd  
2016-17/Reg

2016-17

### CONTROL SYSTEM

EE - 503

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Answer should be brief and to the point.

All parts of any question should be written in one place.

Answer question no. 1 and any five from the rest.

1. Answer any five : 5×2=10

- (i) Draw a practical PD controller with suitable electrical/electronic components and hence show the different gains.
- (ii) Most of the control systems are designed for damping ratio in the range 0.4-0.7. Why?
- (iii) Show the effect of adding a zero in the forward path of a second-order system.
- (iv) Why Bode plots are commonly used in the frequency domain design?
- (v) Square wave step input signal is generally used for determination of dynamic response of any system' — why?

( 2 )

- (vi) 'In general the no of poles are more than the no of zeros for any system' — why ?

(vii) How do you estimate parameters of a series RLC circuit without using direct measuring instruments ?

2. (a) (i) What is mathematical modeling ?

(ii) Develop a mathematical modelling of an electromagnetic levitation system where a ferromagnetic ball is to be suspended under an I-core electromagnet. Assume controlled current source as an excitation to the magnet coil. 2+4=6

- (b) For the system represented by the following equations, find the transfer function  $\frac{X(s)}{U(s)}$  by signal flow graph technique. 6

$$x = x_1 + x_2 - \beta_3 u, \quad \frac{dx_1}{dt} = -\alpha x_1 + b x_2 - \beta_2 u, \quad \frac{dx_2}{dt} = -c x_1 + \beta_1 u$$

3. (a) A unity feedback system has open loop transfer function

$$G(s) = \frac{\omega_n^2}{s(s + 2\xi\omega_n)}; \quad \xi < 1; \quad \text{Derive}$$

expressions for (i) rise time, (ii) peak time and (iii) steady-state error of the time response of the given system to the unit step input. 2+2+2=6

( 3 )

- (vi) The unity feedback system with  $G(s) = \frac{K(s+\alpha)}{(s+\beta)^2}$  is to be designed to meet the following specifications. Steady state error for a unit step input = 0.1 rad, damping ratio = 0.5, natural frequency =  $\sqrt{10}$  rad/sec.

Find K,  $\alpha$  and  $\beta$ . 2+2+2=6

4. (a) A servo position control system is working in stable condition and maintaining good performance. Now the gain of the system is increased to sufficiently high value. How will the transient and steady-state performance of the system be affected ? Establish your answer by writing expression of different specifications.

- (b) A second order mechanical system is represented by the transfer-function  $\frac{\theta(s)}{F(s)} = \frac{1}{Js^2 + Bs + K}$

input of 10 N-m is applied to the system and the results are given below :

Maximum over shoot = 6%, Time at peak over shoot = 1 sec, The steady state value of the output 0.5 rad. Determine the value of J, B and K. 6

5. (a) Explain the effect of different controllers (P, I and D) on the transient and steady- state performance of feed-back control systems. 2+2+2=6

( 4 )

- (b) The open loop transfer function of a unity feedback system is

$$G(s) = \frac{K(s+2)}{s^2(s^2 + 6s + A)}$$

- (i) Find the relation between A and K so that the system is stable.

- (ii) Show on an A-K plane the region of stability.

6. (a) Define gain margin (GM), phase margin (PM), gain crossover frequency (GCF) and phase crossover frequency (PCF) with reference of a type-1 3<sup>rd</sup> order system.  
6

- (b) The open loop transfer function of a feedback system

$$\text{is } G(s) = \frac{K}{(s+1)(s+2)(s+3)}$$

- Draw Nyquist plot and find the range of values of K for which the system remains stable.  
4+2=6

7. (a) Explain (i) absolute stability, (ii) relative stability and (iii) marginal stability with suitable examples. 2+2+2=6

- (b) Construct the root-locus plot for a feedback system with characteristic equation  $(s+2)(s+3)(s+4) + K(s+1) = 0$ ; Comment on the effect of open-loop zero on the system performance.  
4+2=6

8. The open loop transfer function of a unity feedback system

$$\text{is given by } G(s) = \frac{4}{s(1+0.2s)(1+0.05s)} \quad 8+2+2=12$$

( 5 )

- (i) Draw the Bode plot.  
(ii) Find the phase margin and gain margin.  
(iii) Comment on stability of the system.

9. The open loop transfer function of a unity feedback system is given by  $G(s) = \frac{k}{s(s+2)}$ . Design a lead compensator to have a velocity-error constant of  $20 s^{-1}$  and a phase margin of at least 50 deg.  
12

10. Write short notes (any three):  
4+4+4=12

- (i) Classification of feed-back control system.  
(ii) Closed loop control of Automatic Voltage Regulator (AVR).  
6

- (iii) State space model of field controlled DC motor.  
(iv) Analogy between Gear Train and Transformer.  
\_\_\_\_\_

**Q. No. EE - 504 / 107**

**B. Tech./Odd**  
**2016-17/Reg**

**2016-17**

**POWER ELECTRONICS**

**EE - 504**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer question no. 1 and any four from the rest.

All parts of a question are to be answered at same place.

1. (a) Considering the stored charge distribution in base and collector drift regions of a power BJT, is as per the Fig.1 (a), identify the region of operation of the device.

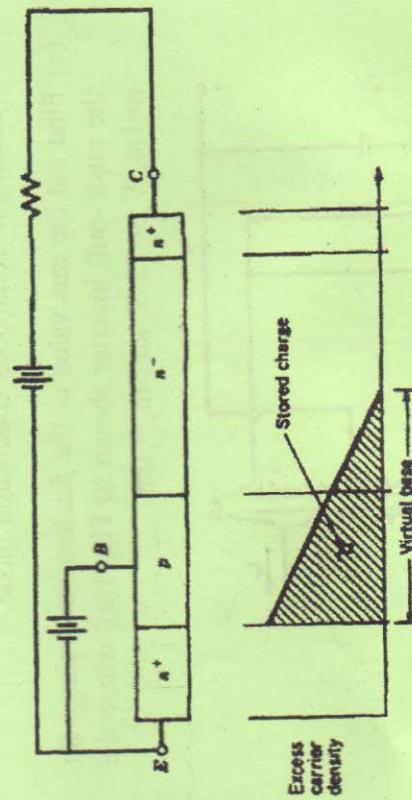


Fig. 1 (a)

- (b) Explain, why the rate of rise of anode current be kept less than a maximum value for the thyristors ?

P.T.O.

( 2 )

- (c) Find out the switch utilization ratio of the single phase full converter, supplying a load with back emf  $E_d$ , while the input voltage  $V_s$ . (Both are expressed in rms value).

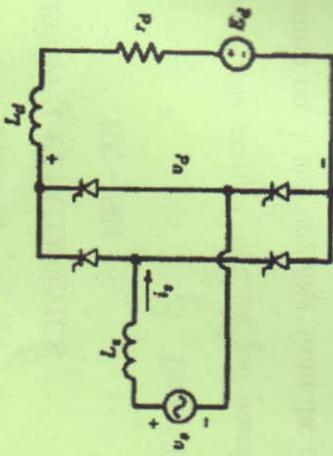


Fig. 1(c)

- (d) Draw the instantaneous diode current and inductor current wave forms of a buck-boost converter, while operating at continuous conduction mode.
- (e) Find out the rms value of the fundamental voltage for the push-pull inverter shown in Fig. 1(e), where the  $n=1/4$ ,  $V_d = 12$  V, and  $m_a = 0.8$ .

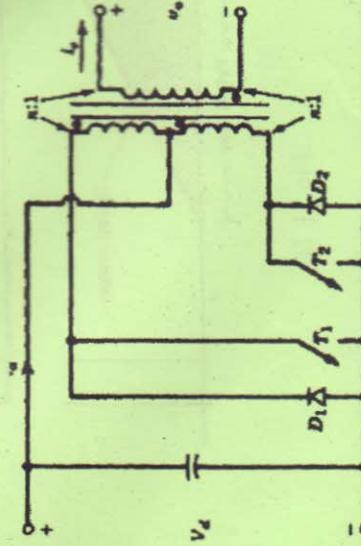


Fig. 1(e)

( 3 )

2. (a) Draw the voltage and current waveforms for a power diode during turn-on and turn-off durations, and explain all time intervals of the waveforms separately.
- (b) Describe any modification in an inductively loaded BJT power circuit, to increase the safe operating area of the device by reducing the power loss during turn-on and turn-off transients.

- (c) Draw the two-transistor equivalent circuit of a thyristor and explain the turning on of the device with positive gate pulse with help of the diagram.

3. (a) Explain the turn-off transients in device current and voltage of a MOSFET, connected with a diode clamped inductive load in a step-down dc-dc converter, through required waveforms.
- (b) Find the expression of average output voltage of the circuit shown in Fig. 3(b), where the input voltage frequency is  $\omega_s$ .

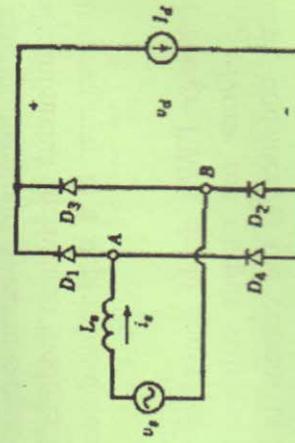


Fig. 3(b)

( 4 )

- (c) Draw the AC regulator circuit with TRIAC, fired through DIAC and explain the operation in brief.

$$5+5+4=14$$

4. (a) Consider any single phase, half-controlled converter, operating with a firing angle  $\alpha$ , such that the average output voltage is half of the maximum achievable average voltage. Calculate the firing angle  $\alpha$ , and find the input power factor at that instant.

- (b) A three phase full wave converter is supplying a continuous load at firing angle  $30^\circ$ . Draw the current wave form of any one device of the converter and find the r.m.s. value of it. Also find the percentage reduction in load voltage with firing angle  $60^\circ$ .

5. (a) If the total ripple current flows through capacitor and the average current flows through the load, then derive the expression of percentage output voltage ripple in a buck-boost converter, operating at continuous conduction mode.

- (b) Prove that, the maximum value of output current at the edge of continuous conduction mode is less than that of inductor current in a step-up dc-dc converter.

$$7+7=14$$

6. (a) In full bridge PWM dc-dc converter  $V_{control} = 0.5 V_{tri (peak)}$ . Draw the output voltage and current waveform, considering the current is having both positive and negative instantaneous values, with average positive value. Also explain the quadrants of operation by the converter in this case.

( 5 )

- (b) In a full bridge PWM dc-dc converter, analytically obtain the value of  $(V_o/V_d)$  which results in the maximum (peak-peak) ripple in the output voltage. Calculate the ripple in terms of dc voltage, switching frequency and duty ratio.

7. (a) Draw a possible harmonic spectrum for the line to line voltage waveform of a three phase PWM voltage source inverter. State the basic considerations of choosing the frequency of switching in this inverter.
- (b) For a three phase voltage source inverter, consider the loads are balanced and induced back e.m.f.s are balanced and sinusoidal. Derive the phase to neutral voltage of the load in terms of switching state of the inverter.

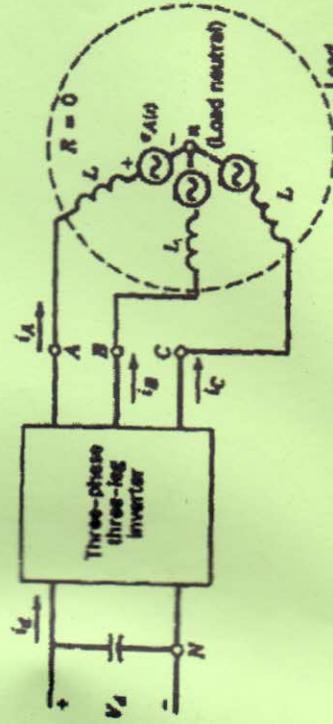


Fig 7(b)

$$7+7=14$$

P.T.O.

( 6 )

8. (a) With the help of circuit diagram and wave forms, describe the operation of single-phase to single-phase cyclo-converter operating at 1/3rd of input frequency.
- (b) Describe one scheme to supply dc load from two dc-ac full converters, connected and operated to emulate the behaviour of semi-converter.
- (c) Show two possible schemes of 3 phase AC to AC voltage regulator, made of SCR.
-

No. EE - 540 / 013

B. Tech./Odd  
2016-17/Reg

2016-17

### MEASUREMENTS AND INSTRUMENTATION

EE - 540

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Attempt any five questions.

1. (a) Write some advantages and disadvantages of PMMC instrument.  
  
(b) Describe and explain with the help of neat sketch the construction and working principle of megger.  
  
(c) Describe the various operating forces needed for proper operation of an analog indicating instruments.  
  
2+6+6=14
2. (a) Describe the Murray loop method for localizing of earth and short circuit faults in cables.  
  
(b) An ac bridge with terminals A, B, C, D (consecutively marked) has in arm AB a pure resistance ; arm BC a resistance of  $800\ \Omega$  in parallel with a capacitor of  $0.5\ \mu F$ ; arm CD a resistance of  $400\ \Omega$  in series with a capacitor of  $1.0\ \mu F$  and arm DA a resistance of  $1000\ \Omega$ . Obtain the value of the frequency for which the bridge can be balanced by first deriving the balance

( 2 )

equations connecting the branch impedances and also calculate the value of the resistance in arm AB to produce balance.

(c) Differentiate between moving iron and moving coil instruments.  
 $6+5+3=14$

3. (a) What is Strain gauge ?

(b) Explain with neat sketch the operating principle of resistive position transducer.

(c) Draw a neat schematic diagram of the Schering bridge. Deduce the equation of Capacitance when the bridge is under balance condition. Draw the phasor diagram of the voltages and currents of the bridge arms at balance.  
 $2+6+6=14$

4. (a) With the help of a neat sketch, describe the construction and working principle of permanent magnet moving iron instruments. What are its advantages and limitations ?

(b) The inductance of a moving iron instrument is given by an expression  $L = (0.01 + K_1 \theta)^2 \mu\text{H}$ . Where  $\theta$  is the deflection in radian from the zero position. The instrument angular deflection corresponding to current of 2 ampers and 5 ampers are  $45^\circ$  and  $90^\circ$  respectively. Find the value of  $K_1$ .

(c) Write some advantages and limitations of thermistor.  
 $(5+1+1)+4+3=14$

5. (a) Derive the expression of power and power factor for three phase power measurement by two wattmeter method (Star connected load).  
 $(1+1)+4+4+(2+2)=14$

( 3 )

(b) Describe the operating principle of a piezo-electric transducer.

(c) The following results were obtained by loss charge method of testing a cable :

(i) Discharged immediately after charging, the deflection is 200 divisions.

(ii) Discharged 30 seconds after charging, the deflection is 125 divisions and

(iii) Discharged 30 seconds after charging, when in parallel with a resistance of  $10 \text{ M}\Omega$  the deflection is 100 divisions. Find the insulation resistance of the cable.  
 $6+4+4=14$

6. (a) What is LVDT? Where is it used?

(b) Explain the operating principle of magnetic flow meter.

(c) In a gravity controlled instrument the controlling weight is 0.005 kg and acts at a distance of 2.4 cm from the axis of the moving system. Determine the deflection in degree corresponding to deflecting torque of  $1.05 \times 10^4 \text{ kg}\cdot\text{m}$ .

(d) A moving coil instrument gives a full scale deflection for a current of 20 mA with a potential difference of 200 mV across it. Calculate (i) shunt required to use it as an ammeter to get a range of 0-200 A.

(ii) Multiplier required to use it as voltmeter of range 0-500 volts.  
 $(1+1)+4+4+(2+2)=14$

( 4 )

7. Write short notes on any *two* from the following :

$$7 \times 2 = 14$$

- (a) Thermocouple type instrument
  - (b) Loss of Charge method
  - (c) Heaviside Campbel bridge
  - (d) Air friction damping
-

**Q. No. HS - 540 / 089**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**INTERNATIONAL BUSINESS AND  
FINANCIAL MANAGEMENT**

**HS - 540**

**Full Marks : 70**

**Time : Three Hours**

*The questions are of equal value.*

Answer any **seven** of the following questions.  $10 \times 7 = 70$

1. In terms of numerical example, examine the comparative advantage theory of Ricardo. Explain the theorem in terms of opportunity cost approach diagrammatically in terms of Box diagram.
2. Explain Heckscher-Ohlin theorem and its limitation by using physical definition of factor abundance.
3. Explain the Gains from Trade and examine the effect of technical progress on the gains from trade.
4. Examine the different effects of Tariff and how does Quota differ from tariff. Which one is more effective for the developing countries like India ?
5. Calculate the Foreign Trade Multiplier of an open economy without government sector. Relate the value of this multiplier with marginal propensity to import of that country.

( 2 )

6. State the Devaluation and the Depreciation with their impacts on trade balance. Prove and explain the Marshall-Lerner condition.
7. What is meant by foreign direct investment (FDI)? Show that inflow of FDI is beneficial for a one sector economy.
8. What is International Liquidity? Explain the role of IMF and World Bank in monitoring International Liquidity, with the mentioning of their basic functions.
9. Explain the process of emergence of globalization and India's entry into the process.

**Q. No. IT - 501 / 099**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**MICROPROCESSOR**

**IT - 501**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer any *five* questions.

1. (a) Explain the modes of 8255A PPI.  
(b) Draw 8255A Mode 1 output configuration and explain the handshake signals.  
(c) The control word of 8255A is 83H. What does it signify? Draw the control word format and explain it.
2. (a) What are the differences between Peripheral mapped I/O mode and memory mapped I/O mode? Give 4 differences.  
(b) How can the memory map of 1K byte chip be changed? Give any 2 different memory map address ranges by changing the memory map configuration.  
(c) How many machine cycles and T states are needed for :
  - i) IN 03H instruction
  - ii) CALL 20CDH
  - iii) STA 2040H

**3+6+5**

**4+(2+2)+6**

**P.T.O.**

( 2 )

3. (a) Give 2 ways in which time delay can be designed. Give proper program with number of machine cycles and T states to show how time delay is generated.
- (b) Design a mod-16 down counter, using 2MHz clock frequency. Give all delay calculations, comments and address locations.

- (c) Draw OPCODE FETCH machine cycle showing the following signals in your time diagram: Clock, address bus, multiplexed data and address bus, ALE, control signals, status signals, I/O/M bar signal.  $(2+2)+5+5$

4. (a) What is the use of ALE?

- (b) What is the importance of rotate instructions? Give 2 points.

- (c) Compare and Contrast JUMP and CALL instructions. Give 3 points.

- (d) Show the data transfer during execution of CALL instruction diagrammatically showing movement of data through SP (Stack pointer), address bus (AB), Program counter (PC), data bus (DB) and temporary registers W and Z.

- (e) What is DAA instruction ? Give an example.

$2+2+3+5+2$

5. (a) Explain the steps of interrupt process.
- (b) What are the maskable and non-maskable interrupts? Name them.
- (c) Compare and contrast the vectored and non vectored interrupts.

( 3 )

- (d) Draw the ACC bit pattern for either RIM or SIM instruction.  
 $5+3+3+3$

6. (a) What is the sequence of serving the following requests?  
INTR, TRAP, RST 5.5, HOLD.

- (b) What is DMA? Explain both modes of operation.  
What signals are present in 8085A to handle DMA?  
(c) What are the different modes of operation of 8254 PIT? Explain any one of them.

- (d) What are the stack instructions? Why is stack initiated at highest location?  
 $2+(1+2+1)+(2+3)+3$

7. (a) What are the priority modes of 8259A PIC ?  
(b) How many priority levels can 8259A handle and how ?  
(c) Neatly draw the block diagram of the 8259 A PIC labeling each part properly.

- (d) What does the initialization command word 76H signify ?  $(ICW1 = 76H)$

8. (a) Write a program to the given on/off time to three signal lights (Green, Yellow, Red) and two pedestrian signs (WALK and DON'T WALK). The signal lights and signs are turned on/off by data bits of an output port as shown below :

| Lights    | Data bits | On Time    |
|-----------|-----------|------------|
| 1. Green  | $D_0$     | 15 seconds |
| 2. Yellow | $D_2$     | 5 seconds  |

( 4 )

3. Red D<sub>4</sub> 20 seconds
4. WALK D<sub>6</sub> 15 seconds
5. DON'T WALK D<sub>7</sub> 25 seconds

Traffic and pedestrian flow are on same direction,  
pedestrian should cross the road when the green signal  
is on.

- (b) Write a main program to count continuously in binary  
with 1 second delay between each count.

Write a service routine at XX70H to flash FFH five  
times when the program is interrupted with some  
appropriate delay between each flash.

9. Pick the correct answer :

- (a) EI is a (1 byte/2 byte/3 byte) instruction.
- (b) The Hex code of RST 5 is (CF/EF/E7)
- (c) NMI is Non maskable interrupt which is RST 5.5/RST  
6.5/TRAP

- (d) The time delay using loop within loop is more than/less  
than /same as time delay using register pair

Fill in the blanks :

- (e) In 8085 A, the index register is \_\_\_\_\_
- (f) LXI SP, 2099 means stack is initiated at \_\_\_\_\_ and  
stack storage starts at \_\_\_\_\_
- (g) The first operation of any instruction to microprocessor  
is \_\_\_\_\_

( 5 )

- (h) \_\_\_\_\_ & \_\_\_\_\_ registers are temporary registers
- (i) \_\_\_\_\_ & \_\_\_\_\_ are special registers
- (j) \_\_\_\_\_ & \_\_\_\_\_ are two mapping modes of  
I/O addressing.

**Q. No. IT - 502 /**      **1 0 0**

**B. Tech./Odd**  
**2016-17/Reg**

**2016-17**

### **THEORY OF COMPUTATION**

**IT - 502**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer Question no. 1, 2 and any six from the rest.

1. Select the most correct alternative. Justify your answer wherever necessary.

- 1.1 The minimum length string generated by the regular expression  $(a+b+c)(a+b)(a)$  over  $\Sigma = \{a, b, c\}$  is

- (i) 3  
(ii) 6  
(iii) 1  
(iv) 0

- 1.2 Consider the following grammars over  $\Sigma = \{\{, \}\}$  with balanced parenthesis.

Grammar 1      Grammar 2

$S \rightarrow SS$        $S \rightarrow (S)S$

( 2 )

$$S \rightarrow (S) \quad S \rightarrow (S)$$

$$S \rightarrow \phi \quad S \rightarrow ( )S( )$$

Which of the above grammar is ambiguous

- (i) Only Grammar 1
- (ii) Only Grammar 2
- (iii) Both the grammar
- (iv) None of the above

1.3 Which are not regular

$$(A) L = \left\{ a^n b^n \mid n > 0 \right\}$$

$$(B) L = \left\{ a^n b^m c^n \mid m, n > 0 \right\}$$

$$(C) L = \left\{ a^{m+n} \mid m, n > 0 \right\}$$

- (i) Only A
- (ii) Only B
- (iii) Only C
- (iv) Only A and C

( 3 )

1.4 Let  $aAbBc$  be a sentential form where  $a, b, c \in \Sigma$  and  $A, B \in V_N$ . Consider the production rules

$$aA \rightarrow aa$$

$$bB \rightarrow bb$$

The immediate next sentential form using the LMD (Left Most Derivation) would be

- (i)  $aAbBc$
- (ii)  $aabBc$
- (iii)  $aabbC$
- (iv) None of the above

1.5 The transition function of a Deterministic PDA is defined as

- (i)  $\delta: Q \times \Sigma \times \Gamma \rightarrow Q \times \Sigma$
- (ii)  $\delta: Q \times \Sigma \times \Gamma \rightarrow Q \times \Sigma^*$
- (iii)  $\delta: Q \times \{\Sigma \cup \phi\} \times \Gamma \rightarrow Q \times \Gamma^*$
- (iv)  $\delta: Q \times \{\Sigma \cup \phi\} \times \Gamma \rightarrow Q \times \Gamma$

1.6 The acceptance criteria of an empty stack PDA is  
 (  $q_0$  initial state,  $w$  the input,  $Z$  initial STACK,  
 $q_f$  general state,  $q_f$  final state,  $\alpha \in \Gamma^*$ ,  $\beta \in \Sigma^*$  )

( 4 )

- (i)  $ID_0(q_0, w, Z) \rightarrow ID_F(q_i, \phi, \phi)$
- (ii)  $ID_0(q_0, w, Z) \rightarrow ID_F(q_f, \phi, \phi)$
- (iii)  $ID_0(q_0, w, Z) \rightarrow ID_F(q_f, \phi, \alpha)$
- (iv)  $ID_0(q_0, w, Z) \rightarrow ID_F(q_i, \beta, \phi)$

1.7 Consider the grammar  $G$  as below :

$$S \rightarrow XSX \mid R$$

$$R \rightarrow aTb \mid bTa$$

$$T \rightarrow XTX \mid X \mid \phi$$

$$X \rightarrow a \mid b$$

Which of the following is not in  $L(G)$ 

- (i)  $abab$
- (ii)  $baba$
- (iii)  $bbbb$
- (iv)  $aabb$

1.8  $RE$  be the set of recursively enumerable language, and  $R$  be the set of recursive language. Which of the following statement is correct.

- (i)  $RE \subset R$
- (ii)  $R \subset RE$

( 5 )

- (iii)  $R$  and  $RE$  are disjoint
- (iv) None of the above

1.9 Which of the following productions are in Chomsky Normal Form (CNF).

- 1.  $A \rightarrow bC$
- 2.  $A \rightarrow BC$
- 3.  $A \rightarrow c$

(i) Only Production 1.

(ii) Production 1 and 2 both.

(iii) Production 2 and 3 both.

(iv) None of the above.

1.10 Let  $(10 + 01)1^*(11 + 00)$  be the regular expression for the language  $L$ . Find the regular expression for the language  $L_R$ .

- (i)  $(01 + 10)1^*(11 + 00)$
- (ii)  $(11 + 00)*1(10 + 01)$
- (iii)  $(11 + 00)1^*(10 + 01)$
- (iv) None of the above.

1.11 The intersection of the  $\{0^*1\}$  and  $\{10^*\}$  would be

- (i)  $\{0^*1^*\}$
- (ii)  $\{1\}$

( 6 )

(iii)  $\{1^*\}$

(iv) None of the above

1.12 The maximum length string generated by the regular expression  $(a+aa+aaa)b(c+cc+ccc)$  is

(i) 3

(ii) 6

(iii) 7

(iv)  $\infty$

1.13  $L_1$  and  $L_2$  are two regular languages. Consider the two statements :

Statement 1 :  $L_1 \cap L_2$  is regular language.

Statement 2 : If  $L_2 \subset L_1$  then  $L_1 - L_2$  is always regular.

(i) Only Statement 1 is correct

(ii) Both Statement 1 and 2 are correct

(iii) None of the Statement is correct

(iv) Only Statement 2 is correct

1.14 The regular expression of the language over  $\Sigma = \{1, 0\}$  where the 3rd alphabet from right is 0. (Assume the strings are at least of length 3)

(i)  $(1+0)^*0(1+0)(1+0)$

( 7 )

(ii)  $(1+0)0^*(1+0)(1+0)$

(iii)  $(0(1+0)(1+0))^+$

(iv)  $(1+0)^*000$

1.15 The Turing Machine has the following states of Acceptance

(i) Accept with Halt and Reject with Halt

(ii) Accept with Halt, Reject with Halt and Loop for ever

(iii) Accept with Halt

(iv) Accept with Halt and Loop for ever

1.16 Consider the following Problem Definition

Problem 1: Whether a given number  $n$  is Prime.

Problem 2:  $G_1$  and  $G_2$  are two grammars of same type. Whether  $L(G_1) = L(G_2)$ .

(i) Problem 1 is recursively enumerable

(ii) Problem 2 is recursive

(iii) Problem 2 is recursively enumerable

(iv) Problem 1 is recursive

( 8 )

1.17  $L_1$  is a context free language and  $L_2$  is a regular language. Which of the following is FALSE ?

- (i)  $L_1 \times L_2$  is context free

- (ii)  $L_1 \cap L_2$  is regular

- (iii)  $\Sigma - L_1$  is context free

- (iv)  $L_1^*$  is context free

1.18 Consider the NDFSM as in the following matrix :

|       | a          | b          |
|-------|------------|------------|
| $p_0$ | $p_0, p_2$ | $p_0, p_1$ |
| $p_1$ | $p_1$      | $p_0, p_1$ |
| $p_2$ | $p_2, p_1$ | $p_2$      |

How many final states would be there for the DDFSM of the given NDFSM ?

- (i) 1

- (ii) 2

- (iii) 3

- (iv) 4

( 9 )

- (iii)  $ab^*$

- (iv)  $\phi$

1.20 Consider the DDFSM given below

The number of states in the minimized FSM of M is

- (i) 1

- (ii) 2

- (iii) 3

- (iv) 4

$1 \times 20 = 20$

2. Select the most correct alternative. Give your justification.

2.1 Consider the PDA as follow :

$$\delta(q_0, a, Z) \rightarrow (q_0, AZ)$$

$$\delta(q_0, b, Z) \rightarrow (q_0, BZ)$$

$$\delta(q_0, a, A) \rightarrow (q_0, AA), (q_0, \phi)$$

$$\delta(q_0, b, B) \rightarrow (q_0, BB), (q_0, \phi)$$

$$\delta(q_0, a, B) \rightarrow (q_0, AB)$$

$$\delta(q_0, b, A) \rightarrow (q_0, BA)$$

$$\delta(q_0, \phi, Z) \rightarrow (p_f, \phi)$$

Let we input the strings

A abba

B abbaab

- (i)  $b^*$

- (ii)  $a^*$

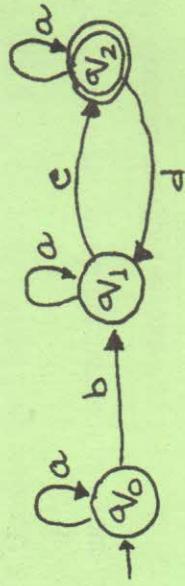
( 10 )

The PDA will accept

- (i) Only A
- (ii) Only B
- (iii) Both A and B
- (iv) Rejects both A and B

2.2 Consider the following DFSM

The regular expression of the FSM is



- (i)  $a^*(ba^*(c+d))^*a^*$
- (ii)  $(a+b)a^*(c+d)^*a^*$
- (iii)  $a^*ba(c+d)^*a^*$
- (iv)  $a^*ba^*c(a+da^*)^*$

2.3 Consider the following DFSM that recognizes the language L :

How many Final States are there for the DFSM that recognizes the language  $\Sigma^* - L$ .

- (i) 1
- (ii) 2

( 11 )

(iii) 3

(iv) 4

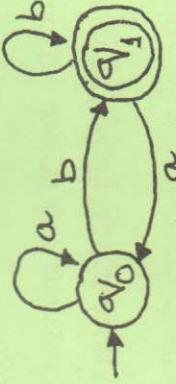
2.4 Consider the following context free grammar

$$S \rightarrow aSa \mid bSb \mid c$$

How many additional nonterminals would be required to form the grammar to Chomsky's Normal Form (CNF)

- (i) 1
- (ii) 2
- (iii) 3
- (iv) 4

2.5 Consider the DFSM as below :

The Arden's State Equation for  $q_0$  is

- (i)  $q_0 = aq_0 + aq_1$
- (ii)  $q_0 = q_0a + q_1a$
- (iii)  $q_0 = \phi + aq_0 + aq_1$
- (iv)  $q_0 = \phi + q_0a + q_1a$

( 12 )

2.6 Let  $T$  be a Turing machine with the transition as follows :

$$\delta(q_0, 0) \rightarrow (q_1, 0, R) \quad \delta(q_0, 1) \rightarrow (q_2, 1, R)$$

$$\delta(q_1, 0) \rightarrow (q_0, 0, L) \quad \delta(q_2, 1) \rightarrow (q_0, 1, L)$$

$$\delta(q_1, 1) \rightarrow (q_2, 1, R) \quad \delta(q_2, 0) \rightarrow (q_1, 0, R)$$

$$\delta(q_1, B) \rightarrow (q_1, B, H) \quad \delta(q_2, B) \rightarrow (q_2, B, H)$$

where  $q_h$  is the halt state.  $B$  is the blank symbol.

For what input the TM loops for ever. Let initially TM be at left of the input.

- (i) 1010
- (ii) 0101
- (iii) 1100
- (iv) None of the above

2.7 Consider the context free grammar  $S \rightarrow aSb \mid c$ . The Nondeterministic PDA that accepts the language is given as :

$$\delta_1(q, a, a) \rightarrow (q, \phi)$$

$$\delta_2(q, b, b) \rightarrow (q, \phi)$$

$$\delta_3(q, c, c) \rightarrow (q, \phi)$$

$\delta_4$  and  $\delta_5$

( 13 )

Which of the following is the correct ?

(i)  $\delta_4(q, S, \phi) \rightarrow (q, bSa)$

$\delta_5(q, S, \phi) \rightarrow (q, c)$

(ii)  $\delta_4(q, \phi, S) \rightarrow (q, bSa)$

$\delta_5(q, \phi, S) \rightarrow (q, c)$

(iii)  $\delta_4(q, S, \phi) \rightarrow (q, aSb)$

$\delta_5(q, S, \phi) \rightarrow (q, c)$

(iv)  $\delta_4(q, \phi, S) \rightarrow (q, aSb)$

$\delta_5(q, \phi, S) \rightarrow (q, c)$

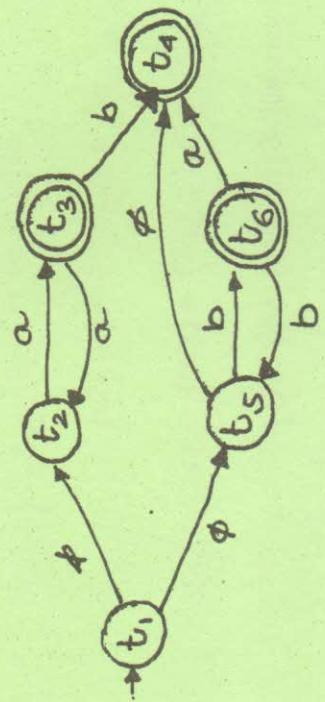
2.8 The regular expression  $(11^*00+0)^*1^*$  defines the regular set

- (i) All binary strings having at least one 0
- (ii) All binary strings having no consecutive 0
- (iii) All binary strings having no substring as 101
- (iv) All binary strings having no more 0s than 1s

( 14 )

2.9 Consider the NDFSM as below :

The  $\phi$ -CLOSURE  $\{t_1\}$  is



(i)  $\{t_1, t_2, t_5\}$

(ii)  $\{t_1\}$

(iii)  $\{t_1, t_2, t_4, t_5\}$

(iv)  $\{t_4\}$

2.10 Consider the context free grammar

$$S \rightarrow aSbS \mid bSaS \mid \phi$$

The height of the derivation for the string abbaba would be

(i) 4

(ii) 5

(iii) 6

(iv) 7

( 15 )

3.1 Design the Grammar for the following (any one)

- (A) All strings over  $\{a, b\}$  those start and end with the same alphabet.

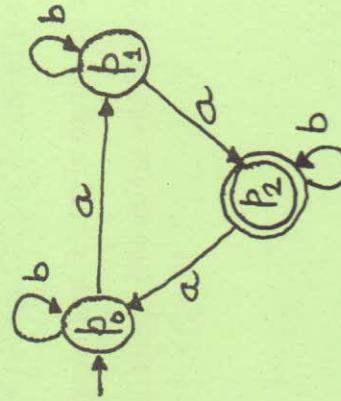
- (B) All strings over  $\{1, 0\}$  those are divisible by 3.

3.2 Design regular expression for the following (any one).

- (A) All strings over  $\{a, b\}$  having at most two as.  
 (B) All strings over  $\{a, b\}$  where the length of the strings is divisible by 3.  $2.5 \times 2 = 5$

4. Design the DFSM over  $\Sigma = \{0, 1\}$  that accepts the strings of binary having even length and every 1 is followed by at least one 0. 5

5. Find the regular expression using Arden's Theorem of the given DFSM.



( 16 )

6. Design the Deterministic PDA (Empty Stack) for the following (any one).

(A)  $L = \{a^n b^{2n} \mid n > 0\}$

- (B) All strings over  $\{a, b\}$  with equal number of  $a$ s and  $b$ s.

5

7. Using pumping lemma show that the following languages are not regular (any one).

- (A)  $L = \{a^{i^2} \mid i > 0\}$ . All strings over  $\{a\}$  with length as perfect square.

5

(B)  $L = \{a^n b^n \mid n > 0\}$ .

8. Design Turing Machine for the following (any one). Consider that the HEAD would be initially placed at the Left of the Input.

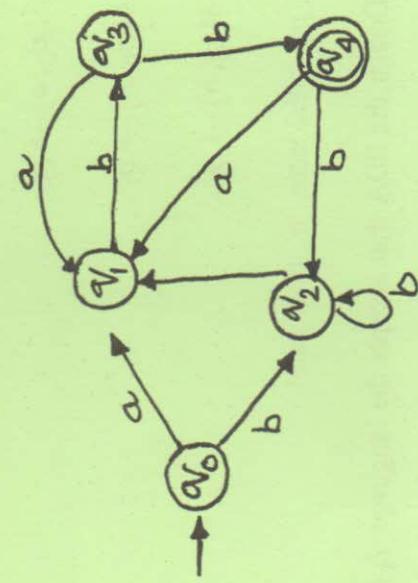
- (A)  $L$  are the strings of palindrome over  $\{a, b\}$ .

- (B)  $L$  are the binary strings with equal number of 1s and 0s.

5

( 17 )

9. Minimize the following DFSM.



5

10. Let  $M_1$  be a PDA that accepts the language  $L_1$  and given below :

$$\delta(q_0, a, Z) \rightarrow (q_1, AZ)$$

$$\delta(q_1, a, A) \rightarrow (q_1, AA)$$

$$\delta(q_1, b, A) \rightarrow (q_1, \phi)$$

$$\delta(q_1, \phi, Z) \rightarrow (q_f, \phi)$$

( $q_0$  initial state,  $Z$  initial Stack,  $q_f$  final state)

( 18 )

And  $M_2$  be the FSM that accepts the language  $L_2$  and given below :

$$\delta(p_0, a) \rightarrow p_0$$

$$\delta(p_0, b) \rightarrow p_1$$

$$\delta(p_1, b) \rightarrow p_1$$

(  $p_0$  initial state,  $p_1$  final state )

Design the PDA that accepts the language  $L_1 \cap L_2$ . 5

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2016-17  
Computer Networks  
IT-503

Full Marks: 70

Time: 3 hours

**Answer any five Questions.**  $5 \times 14 = 70$

1. (a) A modulation scheme uses 2 amplitudes and 8 phases for each amplitude. Show a possible constellation diagram of the scheme. If the symbol transmission rate of the channel is 4000 symbols per second, then find the information carrying capacity of the channel in bits per second. (4)  
(b) A typical data source can be in two possible states i.e, either **ON** or **OFF**. When in **ON** state, it sends data at the rate of  $10Mbps$  but during **OFF** state it sends nothing. The stationary probabilities of **ON** and **OFF** states are 0.1 and 0.9. If the sources are to be multiplexed using TDM within a link of bandwidth  $100Mbps$ , then how many such sources can be multiplexed? If statistical multiplexing is used with infinite buffering, then how many sources can be multiplexed? What is the value of statistical multiplexing gain and what penalty do we pay for this gain? ( $2 + 2 + 2 = 6$ )  
(c) The capacity of an wired network is always significantly higher than that of its wireless counterpart. Show two fundamental reasons behind the wide gap. (4)
2. (a) Say the bit pattern 01111110 is being used to mark the beginning and end of a frame. If the user's data contains a sequence 0111110101, then how should you modify the sequence using stuffed bits, before sending? Also, explain how destuffing can be applied at the receiving side to get back the original sequence? ( $2 + 2 = 4$ )  
(b) A link has a bitrate of  $10Mbps$  and its length is  $2000Km$ . If the packets are 10Kbits long, then find the transmission time and propagation time of a packet through the link. Assume that the velocity of signal in the link is  $2 \times 10^5 Kmps$ . Also calculate the round-trip-time of packet transmission. What should be the optimum window size (in terms of number of packets) to achieve 100% efficiency? What should be the maximum sequence number of the packets? ( $1+1+2+2+1 = 7$ )  
(c) What should be the minimum Hamming distance of a coding scheme if it is to be designed to correct all error upto  $d$  number of bits?

Justify your answer. A coding scheme can detect all errors upto 4 bits - what should be the minimum Hamming distance? (2 + 1 = 3)

3. (a) Compare the performance of 1-persistent CSMA and non-persistent CSMA on the basis of collision probability and idle-time of the channel. Which protocol would you prefer under light condition and heavy load condition. (2 + 1 = 3)  
(b) How does a node update its collision window value if it experiences a collision and if it has successfully transmitted a frame? In this context, explain how an adaptive  $p$ -persistent CSMA system evolves with time. Will the size of collision windows of all the nodes be same? (2 + 2 + 1 = 5)  
(c) With neat sketches explain the hidden station and exposed station problems encountered in wireless LAN. Explain how the hidden node problem can be solved using RTS/CTS signalling. Can you solve the exposed station problem with the same signalling scheme? (2+3+1 = 6)
4. (a) 'The routing decision is initially taken by the source node but all the intermediate nodes decide the actual route independently' - why is it designed so? What is the fundamental difference between distance-vector and link-state routing? Which one of them is more advantageous? (2 + 2 + 1 = 5)  
(b) Customers arrive at a bank counter according to Poisson's process with an average rate of arrival 16 customers per hour. The capacity of the serving clerk is 20 customers per hour. If the service times are exponentially distributed, find the average number of customers in the queue. Also compute the average waiting time of a customer being served at the counter. (2 + 1 = 3)  
(c) A network switch has 4 input ports and 4 output ports. The packets coming through any of the input ports are destined for all the output ports with uniform probability. The arrival process is Poisson's process with average of 800 packets per input port per second. The output ports are equipped with buffers and can transmit 1000 packets per second. When buffer length is infinite, find the average buffer occupancy and average time spent by a packet in the queue including its own service time. If the length of the buffer is 200 packets, then what is the probability that a packet will be lost? If the length of the buffer is made 400 packets, then what is the loss probability? (2 + 1 + 1 + 2 = 6)
5. (a) Why the IP protocol had been designed as 'connectionless and unreliable'? Why hierarchical addressing had been adopted in the Internet? (2 + 2 = 4)  
(b) Why is it necessary to include the 'header-length' field in the IP-header? If you want that the packets in an IP network should never

- visit more than 16 nodes, how will you implement this using standard IPV4 headers? ( $2 + 3 = 5$ )
- (c) A node receives an IP-datagram of length  $4KB$  through a serial link. The packet is to be delivered through a link that allows a maximum frame-length of  $1.5KB$ . How many fragments must be created from the original datagram? Show the 'identification field', 'fragment-offset field', and 'MF flag' for each of the fragments. ( $1+1+2+1 = 5$ )
6. (a) How does TCP guarantee connection oriented transport service using underlying connectionless IP protocol? With a neat sketch illustrate the connection establishment phase of TCP. ( $2 + 2 = 4$ )
- (b) What is the significance of  $ACK$  and  $WINDOW$  fields of TCP header? ( $2 + 1 = 3$ )
- (c) A file of size  $90KB$  is to be sent using TCP protocol through a route having average RTT value of  $10ms$ . Assume that the  $WINDOW$  field and  $THWND$  value are very high (practically infinite) and segment size is  $1.5KB$ . If there is no error in the channel, then how long will it take to send the complete file? If an error occurs in the  $31^{st}$  segment and no more error occurs after that, then how long will it take to transmit the file? ( $3 + 4 = 7$ ).
7. (a) With a neat sketch, explain how discretionary access control is implemented in a computer system. What is the difference between authorisation and authentication? ( $3 + 2 = 5$ )
- (b) What is the fundamental limitation of symmetric key based encryption? How has it been eliminated using public-private key pair? Mention two important operational characteristics of public-private key pair. ( $1 + 2 + 2 = 5$ )
- (c) How one way hashing can maintain the integrity of message? How can you use public-private key pair to sign a message digitally? ( $2+2 = 4$ )

End

**Q. No. IT - 504 / 101**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**DESIGN AND ANALYSIS OF ALGORITHMS**

**IT - 504**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer question number 1 and any *five* from the rest.

Answer them in order.

1. (a) Where in a *max-heap* might the smallest element reside, assuming that all elements are distinct? Justify.

**2**

- (b) Why the runtime of *max-heapify* is bounded by

$$T(n) \leq T(2n/3) + \theta(1)$$

Solve the recurrence using master method.

**1+2**

- (c) Why do we bother setting the key of the inserted node to  $\rightarrow \infty$  in the *max-heap-insert* when the next thing we do is to increase its key to the designed value?

**2**

- (d) Give an  $O(n \lg n)$  time algorithm to merge  $k$  sorted lists into one sorted list, where  $n$  is the total number of elements in all. Write a pseudocode for that.

**5**

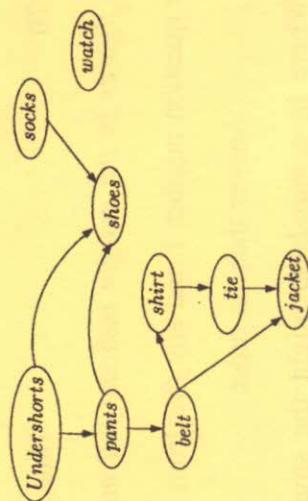
- (e) Prove that the *Build-max-heap* algorithm is correct by the *loop-invariant* technique.

**4**

( 2 )

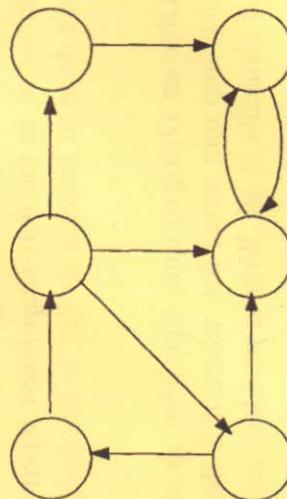
(f) Prove that the running time of BFS procedure is  $O(V + E)$  by the Amortized analysis technique. 4

(g) Say Prof. Robert wants to decide the order in which he should be dressed when the following natural constraints are imposed.



Give an algorithm that will give a proper ordering for his dressing sequence. Analyse the time complexity of your algorithm. Illustrate the procedure. 5

2. Consider the following graph. You can give the name of the nodes according to your own will.



( 3 )

Write an algorithm to find the strongly connected components of the graph. Illustrate the procedure with the above graph. Write the time complexity of your algorithm. 3+3+3

3. (a) Which data structure is used to implement Kruskal's algorithm? Why do we use that? 1+1

(b) What are the two important heuristics that are used to reduce the time complexity of different operations of that data structure? Discuss with examples. Write the pseudocode of different operations that are supported in that data structure. 2+2+3

4. (a) What are the different *greedy templates* for Interval scheduling problem? 2

(b) Give counter examples for at least three of them, so that it can be shown that they are not optimal. 3

(c) Give a pseudocode for the above interval scheduling problem so that it can be solved optimally. Prove by the exchange argument that your algorithm is optimal. 4

5. (a) Let  $X[1..n]$  and  $Y[1..n]$  be two arrays, each containing  $n$  numbers already in sorted order. Give an  $O(\lg n)$ -time algorithm to find the median of all  $2n$  elements in arrays  $X$  and  $Y$ . Write the pseudo-code. 5

( 4 )

- (b) From which problem does the following recurrence come?

$$T(n) \leq \begin{cases} O(1) & \text{if } n < 140 \\ T\left(\left\lceil \frac{n}{5} \right\rceil\right) + T\left(\frac{7n}{10} + 6\right) + O(n) & \text{if } n \geq 140 \end{cases}$$

Solve the recurrence by substitution method.

6. (a) Prove that the direct recursive implementation of Matrix-chain-multiplication without memorization yields the running time  $T(n) = \Omega(2^n)$ .

- (b) Draw the recursion tree of solving the problem with chain length at least 5. Highlight the overlapping subproblem property in the recursion tree.

- (c) Describe the main observation by which Karatsuba got his improved multiplication algorithm.

7. (a) When does the Ford-Fulkerson method performs badly? Illustrate with an example.

- (b) How does the algorithm be improved? What is the name of that algorithm?
- (c) With an example show how does the Edmond-Carp algorithm behaves on an input graph. Analyse the time-complexity of Edmond-Carp algorithm.
-

**Q. No. IT - 543 / 072**

**B. Tech/Odd  
2016-17/Reg**

**2016-17**

**OBJECT ORIENTED TECHNOLOGY**

**IT - 543**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

*Answer all the questions in order.*

**1. Briefly discuss with example :**

**$2 \times 5 = 10$**

(i) Function definition of operator + in the following instruction: A=2+B, where A and B are the objects of same class.

(ii) Ambiguity that appear in single inheritance and how to overcome that.

(iii) Abstract class in terms of Pure virtual function.

(iv) Compile time polymorphism.

(v) Why templates are known as generic classes ?

**2. (a) Why a base class is made “virtual”? Give example.**

(b) Why functions are made “virtual”? Write a program to show the use of virtual functions.

(c) Discuss different types of Inheritance.

**$3+(2+4)+3$**

( 2 )

3. (a) Specify two operators where friend functions cannot be used during their overloading.  
(b) Specify 4 operators those cannot be overloaded.  
(c) In which situation friend function is compulsory during operator overloading? Discuss with an example.

- (d) Write a program to overload pre-increment and post-increment operators. How the compiler differentiates between them ?  
 $2+2+3+(2+2+1)$

4. (a) Write a program to show the overloading of a template function.

- (b) Write a program to accept an alphanumeric string. Check the string with a proper loop. When any number is encountered, throw exception. Write proper catch block to handle the exception, it will print that a number has been detected.

- (c) What is local class?

- (d) What is the difference between Inline function and Macro ?  
 $3+(2+2+1)2+2$

5. (a) How the constructor of derived class will be written in case of multilevel inheritance? Discuss with an example.

- (b) State the rules related to static member variables. Given an example and discuss.

- (c) Specify destructors and their use.  
 $5+(2+3)+2$

( 3 )

4×3

6. Short note :

- (a) Initialization list.  
(b) Program to bridge between two classes using friend function.  
(c) Passing and returning objects as argument.  
\_\_\_\_\_

**C** No. M - 542 / 046

**B. Tech./Odd**  
**2016-17/Reg**

**2016-17**

**LINEAR ALGEBRA (OPEN ELECTIVE)**

**M - 542**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

The given symbols have their usual meanings.

Answer question no. 1 and any four from the rest.

**14+(14×4)**

1. (a) Does there exist a linear transformation  $T: \mathbb{R}^2 \rightarrow \mathbb{R}^2$  such that  $T(1, 2) = (c, c)$  and  $T(2, 3) = (c, c)$ , for some non-zero real number  $c$ ? Justify your answer. **4**
- (b) Let  $T$  be a linear transformation from  $\mathbb{R}^3$  to  $\mathbb{R}^2$ , and let  $U$  be a linear transformation from  $\mathbb{R}^2$  to  $\mathbb{R}^3$ . Prove that the transformation  $UT$  is not invertible. Generalize the result. **5**
- (c) Let  $V$  and  $W$  be vector spaces over the field  $F$  and let  $U$  be an isomorphism of  $V$  onto  $W$ . Prove that the function  $f: L(V, V) \rightarrow L(W, W)$ , defined by  $f(T) = UTU^{-1}$  is an isomorphism. **5**

( 2 )

2. (a) Consider the IPS  $P_2(\mathbb{R})$  with an inner product defined by

$$\langle f, g \rangle = \int_{-1}^1 f(t)g(t)dt.$$

Find an orthonormal basis for it. Express  $f(x) = 1 + 2x + 3x^2$  as a linear combination of the vectors from an orthonormal basis.

4+4

- (b) Consider  $S = \{(1, 0, 1), (0, 1, 2), (0, 1, 1)\} \subset \mathbb{R}^3$  with respect to the standard inner product. Can you find an orthonormal basis for  $\mathbb{R}^3$  from here? If yes, find it, otherwise justify your answer.

6

3. (a) Prove that if  $W_1$  and  $W_2$  are subspaces of  $V$ , then so is  $W_1 \cap W_2$ . What can be said about  $W_1 \cup W_2$ ?

3+3

- (b) Show that the set  $M_{mn}(\mathbb{R})$  of all  $m \times n$  real matrices forms a real vector space. Find a basis for it. What is the dimension of it?

5

4. (a) Show that the matrix  $A = (a_{ij}) \in M_n(\mathbb{R})$ , where  $a_{ii} = 1 \quad \forall i$  and  $a_{ij} \neq 0$  for some  $i > j$  can't be diagonalizable over any field.

$$(b) \text{ Diagonalize the matrix } A = \begin{pmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{pmatrix}$$

Give at least one motivation behind learning diagonalizability of matrices.

6+3

( 3 )

5. (a) Solve that the following system of equations using Gauss-Jordan elimination method :

$$\begin{aligned} -3x - 2y + 4z &= 9 \\ 3y - 2z &= 5 \\ 4x - 3y + 2z &= 7 \end{aligned} \tag{6}$$

- (b) Show that the solution space of the following system of linear equations

$$x + 2y - z = 0 = x - y + 5z$$

forms a subspace of  $\mathbb{R}^3$  over  $\mathbb{R}$ . Also, find a basis for it and the dimension of it.

6. (a) Let  $T$  be the linear operator on  $P_2(\mathbb{R})$  defined by

$$T(f(x)) = f(1) + f'(0)x + \{f'(0) + f''(0)\}x^2.$$

Find the matrix of  $T$  with respect to the standard ordered basis  $\beta$  of  $P_2(\mathbb{R})$ . Check the diagonalizability of the operator. If  $T$  is diagonalizable, find an ordered basis of  $P_2(\mathbb{R})$  such that  $[T]_\beta$  is a diagonal matrix.

8

- (b) Let  $T$  be a linear operator on  $\mathbb{R}^3$ , the matrix of which with respect to the standard ordered basis is

$$A = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 1 & 1 \\ -1 & 3 & 4 \end{pmatrix}$$

Find a basis of the null space of  $T$  and determine rank  $T$ .

6

P.T.O.

( 4 )

7. (a) Solve the following system of ordinary differential equations

$$\begin{aligned}\dot{x} &= 3x + y + z, \\ \dot{y} &= 2x + 4y + 2z, \\ \dot{z} &= -x - y + z,\end{aligned}$$

where the symbol denotes the ordinary time derivative.

7

- (b) Obtain the Jordan canonical form of the following matrix

$$A = \begin{pmatrix} 3 & 1 & -2 \\ -1 & 0 & 5 \\ -1 & -1 & 4 \end{pmatrix}$$

---

7

**Q. No. ME - 501 / 157**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**PRODUCTION ENGINEERING II**

**ME - 501**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

- Notations carry their usual meanings.

**First Half**

Attempt any *three* questions.

1. (a) How does a 'continuous type of chip with BUE' is formed? Why is this type of chip not desirable? In your opinion, how does the recrystallization temperature of workpiece material effect the formation of this type of chip?  
(b) During the machining of mild steel with 0-10-6-6-8-90-1 mm (ORS) carbide cutting tool, the following observations have been obtained : Depth of cut = 2 mm; feed = 0.25 mm/rev; cutting speed = 200 m/min; chip thickness = 0.39 mm; cutting (main) force = 310 N; axial (feed) force = 160 N. Calculate :

(i) Shear plane angle;

(ii) Friction force;

(iii) Specific energy of cutting.

**3+1+1+6=11**

( 2 )

2. (a) Define orthogonal cutting process and illustrate various orthogonal machining processes with suitable examples.

(b) What is 'specific energy in cutting' ?

- (c) In an orthogonal turning operation, cutting speed  $V_c = 100$  m/min, feed force  $P_x = 8$  kgf, cutting force  $P_z = 20$  kgf., rake angle  $\gamma = 10^\circ$ , feed  $f = 0.25$  mm/rev, chip thickness  $a_2 = 0.45$  mm, Determine the following :

(i) Shear angle

(ii) Work done in shear

(iii) Shear strain

$$5+1+5=11$$

3. (a) Express  $F_s$  (shear force) and  $N_s$  (normal force on shear plane) in terms of  $P_z$  and  $P_{xy}$  and prove these relations with the help of Merchant's Circle Diagram.

- (b) State Ernst-Merchant theory and prove that,  $2\beta + \eta - \gamma = C_m$  (Merchant's second solution).

( $\beta$  = shear plane angle,  $\eta$  = friction angle,  $\gamma$  = orthogonal rake angle,  $C_m$  = machining constant)

$$6+5=11$$

4. (a) What are the various mechanisms of material transfer in tool wear ? Explain those mechanisms in brief.

- (b) Write down the Taylor's and modified Taylor's tool life equation. Comment on the effect of various cutting parameters on tool life.

- (c) During straight turning of a 20 mm diameter steel bar at 300 rpm with a HSS tool, a tool life of 10 min was obtained. When the same bar was turned at 250 rpm,

( 3 )

- the tool life increased to 40 min. What will be the tool life at a speed of 280 rpm ?  $5+3+4=12$

5. Write short notes on :

- (a) Mechanism of chip formation with a reference of Piispalan's model of card.
- (b) The effect of rake angle and principal cutting edge angle on tool life.
- (c) Machinability of material.

### Second Half

Answer any *three* questions. Assume suitable data, if necessary.

6. (a) What do you mean by deep hole drilling? Discuss about the problems faced in deep hole drilling operation with their causes and possible remedies.
- (b) A hole of 15mm diameter and 30mm length is to be drilled in a mild steel component. Considering cutting speed as 32m/min and feed rate as 0.20mm/rev, calculate machining time and material removal rate.
- (c) Draw twist drill geometry to show point angle and lip length. Also explain their importance in drilling.
- (d) Why does a reground drill consumes more power than a new one while both works for same work piece?

$$(1+2)+3+(2+2)+2$$

7. (a) A C40 steel blank of diameter 54mm, length 100mm is to be turned to work piece of diameter 46mm, length 100mm by rough turning with a finish allowance of 1mm and finish turning. Assume, cutting speed, feed

P.T.O.

**Q. No. ME - 501 / 15<sup>r</sup>**

**B. Tech/Odd**  
**2016-17/Reg**

**2016-17**

**PRODUCTION ENGINEERING II**

**ME - 501**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

- Notations carry their usual meanings.

**First Half**

Attempt any *three* questions.

1. (a) How does a 'continuous type of chip with BUE' is formed? Why is this type of chip not desirable? In your opinion, how does the recrystallization temperature of workpiece material effect the formation of this type of chip ?  
(b) During the machining of mild steel with 0-10-6-6-8-90-1 mm (ORS) carbide cutting tool, the following observations have been obtained : Depth of cut = 2 mm; feed = 0.25 mm/rev; cutting speed = 200 m/min; chip thickness = 0.39 mm; cutting (main) force = 310 N; axial (feed) force = 160 N. Calculate :
  - (i) Shear plane angle;
  - (ii) Friction force;
  - (iii) Specific energy of cutting.

**3+1+1+6=11**

**PTO.**

**Q. No. ME - 502 / 151**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**COMPUTER AIDED DESIGN AND MANUFACTURING**

**ME - 502**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer should be brief and to the point.

Assume suitable data, if necessary.

**Group - A**

Answer any *two* questions.

1. (a) State the difference between Bezier curve and B-spline curve.
- (b) What is the difference between geometric transformation and coordinate transformation?
- (c) The starting and end points of a Hermite cubic spline segment are (-1, 2) and (8, 5) respectively. The tangent vectors at the starting & end points are (8 3) and (6 -14), respectively. Find the equation of the Hermite cubic spline segment and the tangent for a point on the curve at  $u=0.4$ .  
$$2+2+8=12$$
2. (a) Distinguish between synthetic curve and analytic curve.  
What are the different curve construction techniques, explain briefly.

( 2 )

- (b) Find the equation of a Bezier curve which has starting and ending points  $(2, 3, 0)$  and  $(4, -3, 0)$  respectively and is controlled by  $P_1(6, 6, 0)$  and  $P_2(8, 1, 0)$ . Also find its mid point. Write MATLAB code for solving the problem.

3. (a) Write down the major advantages of parametric representation of curves.  
(b) Briefly explain the sweep and loft feature in solid modelling.

- (c) What do you mean by concatenation of transformations? Explain it with suitable examples where it would be required.

- (d) Write down the steps and corresponding basic homogenous transformation matrix for finding the composite homogenous transformation matrix for reflection of a point about a line with slope '0.5774' and y-intercept  $(0, 4)$ .

#### Group - B

Answer any two questions.

4. (a) Write down the different steps involved in an optimal design formulation procedure.  
(b) Distinguish between unconstrained optimization problem and constrained optimization problem.  
(c) Write down the steps involved in Newton-Raphson method for single-variable unconstrained optimization problem.

( 3 )

- (b) Write down the specification of a typical industrial robot.

$$3+2+4+3=12$$

5. (a) What do you mean by dexterous workspace and reachable workspace of a robotic manipulator? Make a list of parameters on which the shape and size of reachable workspace of a manipulator depends.

- (b) Define four D-H parameters for kinematic modelling?  
Which of these parameters are variable of (i) a rotary joint, (ii) a prismatic joint.  
(c) Derive  $4 \times 4$  homogeneous link transformation matrix for kinematic relationship between adjacent links of a serial manipulator. Write MATLAB code.

6. (a) Briefly explain classification of the additive manufacturing processes as per ASTM.  
(b) Briefly describe the major steps involved in a general additive manufacturing process chain.  
(c) With simple sketch, describe the basic process of the Selective Laser Sintering.

#### Group - C

Answer any two questions.

7. (a) What do you mean by CNC? Discuss advantages of using CNC.  
(b) Classify CNC machine tool based on its performance.  
(c) A closed loop CNC Machine tool feed drive end is connected to an encoder. Encoder generates 500

**Q. No. ME - 502 / 151**

**B. Tech/Odd  
2016-17/Reg**

**2016-17**

**COMPUTER AIDED DESIGN AND MANUFACTURING**

**ME - 502**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer should be brief and to the point.

Assume suitable data, if necessary.

**Group - A**

Answer any *two* questions.

1. (a) State the difference between Bezier curve and B-spline curve.  
(b) What is the difference between geometric transformation and coordinate transformation?  
(c) The starting and end points of a Hermite cubic spline segment are  $(-1, 2)$  and  $(8, 5)$  respectively. The tangent vectors at the starting & end points are  $(8 \ 3)$  and  $(6 \ -14)$ , respectively. Find the equation of the Hermite cubic spline segment and the tangent for a point on the curve at  $u=0.4$ .  
$$2+2+8=12$$
2. (a) Distinguish between synthetic curve and analytic curve.  
What are the different curve construction techniques, explain briefly.

**PTO**

**Q. No. ME - 503 /      151**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**THERMAL ENGINEERING - II**

**ME - 503**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

**First Half**

Answer question no. 1 and any *three* from the rest.

1. Discuss the relative advantages and disadvantages of internal combustion engines. 2
2. (a) Describe with a suitable sketch the two stroke cycle SI engine.
- (b) Discuss the differences between ideal and actual valve timing diagrams of a 4-S petrol engine.
- (c) Define the following :
  - (i) Indicated and Brake thermal efficiencies
  - (ii) Mechanical efficiency
  - (iii) Volumetric efficiency and
  - (iv) Specific fuel consumption
3. (a) Describe the Willan's line method ?
- (b) Describe the method commonly used in laboratory for measuring the air supplied to an IC engine.

**3+4+4=11**

**P.T.C.**

( 2 )

- (c) A large diesel engine runs on four stroke cycle at 1440 rpm. The engine has a displacement of 22 litres and a brake mean effective pressure of 0.6 MN/m<sup>2</sup>. It consumes 18 g/s of fuel (C.V. = 42000 kJ/kg). Determine the brake power and brake thermal efficiency.

4. (a) Explain various types of frictional losses in an internal combustion engine.  
(b) Define viscosity index and flash point and discuss their importance in selecting the lubricating oil for an IC engine.  
(c) How the lubricating oils are graded as per SAE ?

- (d) What are 'Multi-grade oils'? What are their advantages ?

5. (a) State how under-cooling and over-cooling of an engine are harmful ?  
(b) Describe with a neat sketch the working of a thermostatic controlled water cooling system.  
(c) Compare the quantity of water required for 90 kW petrol and diesel engines in which water is raised in temperature by 27°C in passing through the jackets. In petrol engine the percentage of energy going to coolant is 32% and in diesel engine 28%. The efficiencies of petrol and diesel engines are 25% and 30% respectively.

6. (a) Describe with a neat sketch the working of a simple constant pressure open cycle gas turbine power plant. How does actual cycle differ from the theoretical ?

( 3 )

- (b) What are the different methods used to improve the thermal efficiency of an open cycle gas turbine power plant ?  
(c) In a gas turbine cycle the pressure ratio is 6. Air enters the compressor at 1 bar, 27°C and leaves at 227°C. The maximum temperature in the cycle is 727°C. Calculate the cycle efficiency, given that the efficiency of the regenerator and the adiabatic efficiency of the turbine are each 80%. Also, show the cycle on a T-s diagram.

### Second Half

Answer any *three* questions.

7. What is controlled during the period of "controlled combustion" in C.I. engine and how is it done ? Why does ignition start rapidly without definite flame front in C.I. engine in comparison to that in S.I. engine ? Indicate the effect of compression ratio and engine speed on flame speed as well as on knocking in S.I. engine. "Auto ignition of end gases must be avoided in S.I. engine whereas earliest possible auto ignition must be initiated in its counterpart" ----- put your comments in this respect in brief. What is the effect of gradual advancement of injection timing on delay period and on peak cycle pressure in C.I. engine ?
8. Indicate two fundamental drawbacks in simple design of carburetor. When is "exhaust gas dilution" severe and what remedial measure is taken for that ? Distinguish between Solex and Carter commercial carburetors in respect of difference and similarity in type, in starting 1+1+2+2+1+3+2=12

( 4 )

arrangement. What are advantages with multi venturi in Carter type? How does emulsion tube in Solex carburettor reduce wastage of fuel at high throttle operation?

9. (a) A four cylinder four stroke S.I. engine with cubic capacity 100cc, was operated at 4500 rpm with A/F ratio 15:1 and volumetric efficiency 0.75. Diameter of carburettor throat was 12mm and that of discharge nozzle was  $1/10^{\text{th}}$  that of throat. Co-efficient of discharge at throat and at nozzle orifice are 0.8 and 0.65 respectively. In case compressibility of air is ignored and surrounding condition is assumed at 100 kPa, 300 K, determine height of discharge tip above fuel level in chamber.

- (b) Following data are available for a C.I. engine: i) Type: Four cylinder, four stroke, ii) Brake power developed 125 kW at 2500 rpm, iii) Cylinder pressure during fuel injection varies from 30 bar to 50 bar when fuel injection pressure varies between 200 bar to maximum 500 bar. iv) Co-efficient of discharge of fuel nozzle orifice is 0.6 and fuel density 750 kg/cubic metre, v) bsfc was calculated as 0.25 kg/kW-hr, assuming average of pressure variation over injection duration of 18° crank rotation, determine total orifice area of nozzles. Consider suitable surrounding condition.

$$6+6=12$$

10. What do you mean by accurate metering in fuel injection system? Why is distributor system most effective amongst solid fuel injection systems? What are the effects of rotation of plunger in two opposite directions on effective

( 5 )

stroke of jerk type fuel injection pump? Indicate the effect of air density on fuel distribution during fuel injection. What are the specific advantages with fuel injection in S.I. engine to supersede carburettion? Amongst various sensors in electronic fuel injection system, indicate separately the objects of using "manifold pressure sensor". Indicate in brief functions of ECU in electronic injection system.

$$1+2+2+1+2+1+2=11$$

11. What are respective limitations with battery ignition and with magneto ignition systems at high or at low speed operation of S.I. engine? What is the effect of gap between breaker points on dwell angle? Indicate functions of condenser in mechanical ignition system. Indicate advantages with transistorised coil ignition system. Why does capacitive discharge ignition system fail in lean mixture? Indicate requirement of fuel distillation temperature to prevent crank case dilution. How does intensity to resist knock alter with higher octane rating in octane scale?

$$2+1+2+2+1+1+2=11$$

**Q. No. ME - 504 / 146**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**HYDRAULIC MACHINES**

**ME - 504**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

**First Half**

*Answer Question 1 and any two from the rest.*

1. (a) Give the comparison between impulse and reaction turbines.  
(b) How the specific speed of a turbine defined?  
(c) What are the functions of a draft tube?  
(d) Why does a Pelton wheel not prone to cavitation?  
$$3+2+3+3=11$$
2. (a) Define and explain Unit quantities of a rotodynamic machines.  
(b) A hydraulic turbine is to develop 1015 kW of power when running at 120 rpm under a net head of 12m. Estimate the maximum flow rate and specific speed for the turbine if the overall efficiency at the best operating point is 92%. In order to predict its performance a

( 2 )

- 1 : 10 scale model is tested under a head of 7.2 m.  
What would be the speed, power output and water  
consumption of the model, if it runs under the condition  
similar to the prototype?  
5+7=12

3. (a) Derive the equation of theoretical power developed by  
a Pelton turbine and its hydraulic efficiency.

- (b) A Pelton turbine is supplied with water at the rate of  
10,000 litres per minute under a head of 125m. The  
buckets deflect the jet through an angle of  $160^\circ$ . The  
speed ratio is 0.465 and the nozzle coefficient is 0.982.  
Sketch the velocity triangles and estimate the  
hydrodynamic force on the buckets, the power  
developed and the efficiency of the turbine. Assume  
10% friction loss relative velocity due to surface  
roughness of the buckets.  
6+6=12

4. (a) Show that for a radially inlet and radial discharge  
reaction turbine the hydraulic efficiency can be  
expressed as

$$\eta_{hyd} = \frac{2}{2 + \tan^2 \alpha_1}$$

where,  $\alpha_1$  = inlet guide vane angle.

- (b) A reaction turbine works at 450 rpm under a head  
of 120 m. Its diameter at inlet is 1.2 m and the flow  
area is  $0.4 \text{ m}^2$ . The inlet guide vane angle and runner  
vane angle at inlet are  $20^\circ$  and  $60^\circ$  respectively.  
Determine :

- (i) The volume flow rate

( 3 )

- (ii) The power developed and  
(iii) The hydraulic efficiency.  
5+7=12

### Second Half

Answer any three questions.

2 marks reserved for overall impression.

(Assume atmospheric and separation heads as

10.0 m and 2.5 m of water respectively)

5. (a) What do you mean by 'negative slip' in a reciprocating  
pump? — Explain with the help of an indicator  
diagram.  
(b) In a double acting reciprocating pump the suction and  
delivery heads are 3.5 m and 5.0 m, lengths of suction  
and delivery pipes are 10.0 m and 15.0 m with a  
common pipe diameter pipe of 10 cm, piston diameter  
15 cm, stroke length 35 cm and friction coefficient for  
the pipes is 0.015. Find the safe working speed and  
corresponding power required to drive the pump.  
4+7=11

6. (a) Derive the percentage of power saved in overcoming  
friction in a single acting reciprocating pump when aided  
by air vessels.

- (b) A single acting reciprocating pump has cylinder  
diameter 250 mm, stroke 400 mm and delivery pipe  
diameter 150 mm. A large air vessel is fitted on the  
delivery side. For a crank speed of 40 rpm, determine

( 4 )

the quantity of water going in or coming out of air vessel when crank makes angles of 45, 180 and 225 degrees from the inner dead centre. Compute the crank angles for which no flow occurs either in or out of the air vessel. Assume SHM of the plunger.

$$4+7=11$$

7. (a) What is a positive displacement pump? Describe its main features through performance characteristics curves.

- (b) Mention at least two types of rotary positive displacement pump. With a neat sketch write a short note on anyone of the above pumps.

- 5+6=11  
8. (a) While comparing in between centrifugal and reciprocating pumps, mention at least two advantages in favour of each.

- (b) What do you mean by NPSH and specific speed for a centrifugal pump?

- (c) The diameter and width of a centrifugal pump impeller are 300 mm and 60 mm respectively. The pump is delivering 144 litres of liquid per second with a manometric efficiency of 85%. The effective outlet vane angle is  $30^\circ$ . If the speed of rotation is 950 rpm calculate specific speed of the pump.

- 2+3+6=11  
9. (a) What do you mean by manometric and hydraulic efficiencies of a centrifugal pump?

- (b) A centrifugal pump having an impeller diameter of 1.0 m delivers 90,000 kg/min of water at a total manometric head of 70 m when running at 750 rpm,

( 5 )

the measured shaft HP being 1700. The impeller vanes are curved back at an angle of 20-degree to the tangent and effective circumferential area at outlet is 0.35 sqm. Assuming leakage loss as 3% of discharge and external losses as 50 HP, determine :

- (i) theoretical head which could be developed if the net HP given to water flowing through the impeller was converted to head without any hydraulic losses;
- (ii) hydraulic efficiency and overall efficiency.

$$4+7=11$$

**2016-17**

**FOUNDRY TECHNOLOGY**

**MM - 501**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer question no. 1 and any four questions from the rest.

1. (a) What are the zones of cupola?
  - (b) What is the difference between blind riser and open riser?
  - (c) What is the 'dump-box' practice in shell moulding?
  - (d) How do you produce SG iron casting?
  - (e) What precautions are taken during melting of aluminium alloys?
  - (f) What are different casting methods for magnesium alloys foundry ?
  - (g) How is a gear blank produced in a foundry ?
  - (h) What is the advantage of jolt squeeze machine in a mechanise foundry?  
 $3 \times 8 = 24$
2. (a) Explain the casting method for producing surgical equipments with a neat sketch.

( 2 )

- (b) Why is this process referred to as expendable casting process?  
(c) What are the other areas of application of this process?

(d) Mention the advantages and disadvantages. 11½

3. (a) What is the furnace used for holding metal in a foundry? Draw a neat sketch of the furnace.

(b) Why is crucible preferred in foundry ?

(c) With a neat sketch explain the running and principle of coreless induction furnace.

(d) What is the precaution taken for selection of charges in induction furnace? 11½

4. (a) The foundry may be described as consisting of metal cycle; mould making cycle and sand cycle, describe in details the sand cycle in a foundry.

(b) What are the basic requirement of a core sand? In what respect does it differ from the moulding sand?

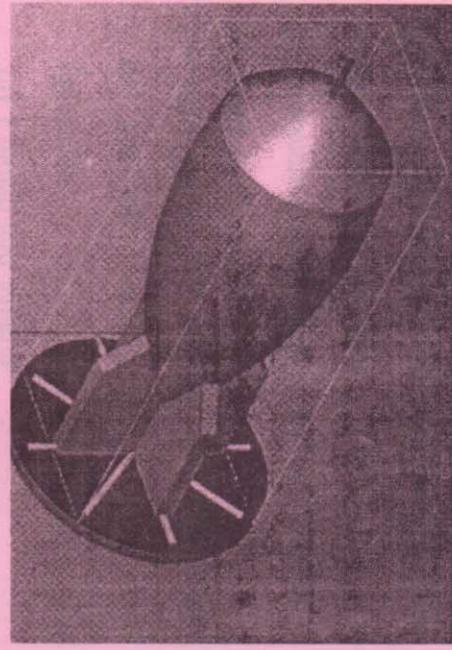
(c) Explain how green strength and permeability are affected by grain shape, grain size, grain size distribution.

(d) How do you determine AFS number of sand? What does it indicate? 11½

5. (a) Discuss the use of chills, Chaplets, exothermic materials and padding in making casting. Illustrate with example.

( 3 )

- (b) Design the gating and risering system for the projectile shown below with a neat sketch along with the type of moulding : 11½



6. (a) What are the phenomenon that happen during solidification of a melt?  
(b) What are the mechanism of dendrite formation?  
(c) Differentiate between progressive solidification and directional solidification.  
(d) What are the methods to have sand casting with no shrinkage voids? 11½
7. (a) What are defects in casting?  
(b) Explain the origin of different defects in casting.

( 4 )

(c) Describe the following defects with causes and remedial measures;

(i) Rattail and Buckles.

(ii) Coldlap and Misrun.

(iii) Scab.

(iv) Warpage.

8. Describe briefly the process you will prefer for the following (Any two) : 11½

(a) Automotive valves made of aluminium alloys.

(b) Gear blank made of steel.

(c) Typewriter segments made of magnesium alloy.

(d) Cast iron pipe.

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**Q. No. MM - 503 / 086**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**HEAT TREATMENT OF METALS AND ALLOYS**

**MM - 503**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

**Part - A**

**Answer Question No.1 and any two from the rest of Part A.**

1. (a) Justify the following statements. **8**
- (i) CCR is slower in coarse grain steel than to that of fine grain steel. **1½**
  - (ii) It is not possible to obtain 100% martensitic structure in low plain carbon steels. **1½**
  - (iii)  $M_s$  and  $M_f$  temperatures change with the composition but are independent on cooling rate. **1½**
  - (iv) Full annealing treatment cannot be recommended as final heat treatment to hypereutectoid steels. **1½**
  - (v) Fully bainitic structure cannot be obtained in plain carbon steel upon continuous cooling. **1**
  - (vi) Austenitisation is faster in fine pearlitic structure than coarse pearlitic steel. **1**

**P.T.O.**

( 2 )

- (b) Indicate the temperature range of various heat treatment processes onto Fe- $\text{Fe}_3\text{C}$  phase diagram. State the significance of  $\text{A}_3$  and  $\text{A}_{cm}$  lines.
- 3
2. (a) Discuss critically austenitisation of steel.
- 7
- (b) Explain how spheroidise annealing treatment is done, state its purpose and the final microstructure.
- 5

- 3 (a) Explain how full annealing treatment causes grain refinement of an initial coarse-grained hypoeutectoid steel.
- 4
- (b) In a 0.40 wt% C steel, normalizing treatment produces harder structure than full annealing treatment — explain.
- 5
- (c) Superimpose CCT curve on the TTT diagram and state the differences.
- 3

4. (a) Describe how to construct TTT diagram of a eutectoid steel. Label all the lines and areas.
- 7
- (b) Superimpose the suitable cooling paths onto the TTT diagram of a eutectoid steel to obtain the following products
- (i) 100% bainite, (ii) 50% medium pearlite and 50% martensite, (iii) 75% upper bainite and 25% martensite and (iv) 50% fine uniform pearlite + remaining martensite.
- 5

5. (a) Discuss tempering treatments subjected of hardened steels.
- 6
- (b) Highlight the important characteristics of martensitic transformation.
- 6

( 3 )

### Part - B

Answer Question No.6 and any two from the rest of Part B.

- 6 (a) Why 0.2% carbon steel carburizes much more easily at 875°C than Armco pure iron
- (9.75Fe – 0.02C – 0.2Mn – 0.015P – 0.015S) ? 2
- (b) Why white layer is formed during nitriding? How it can be prevented?
- 3
- (c) Explain how quenching a carburized steel introduces residual compressive stresses at the surface.
- 3
- (d) Any combination of heat treatment and plastic deformation by cold working cannot be referred to as thermo mechanical treatment — explain.
- 3
7. (a) What are the conditions necessary for precipitation hardening in an alloy?
- 3
- (b) Explain the various changes in structure that take place when a Al-4.5% Cu alloy after solution treatment and quenching is aged at about 130°C.
- 6
- (c) Explain the mechanism of hardening by coherent particles. Explain why hardening effect is reduced during over-ageing?
- 3
- 8 (a) Define and explain the term severity of quench.
- 2
- (b) Describe the Jominy end quench method of determining hardenability.
- 6

P.T.O.

( 4 )

(c) Discuss how hardenability is affected by

- (i) Austenite grain boundary
- (ii) Carbon content

9 (a) What is case carburizing treatment? Explain Pack carburizing process, and show various changes in microstructure with proper sketching.

(b) Why it is necessary to toughen the core before hardening the case?

(c) What is the basic principle involved in thermo-mechanical treatment of steels? Give a classification of thermo-mechanical treatment for steels.

11. Write short notes on any *three* of the following : 4×3

- (i) Heat Treatment of Copper-Beryllium alloys
  - (ii) Post carburizing heat treatment
  - (iii) Induction hardening
  - (iv) Explain Cro-forming process.
-

**Q. No. MM - 502 / 091**

**B. Tech/Odd  
2016-17/Reg**

**2016-17**

**TESTING OF MATERIALS**

**MM - 502**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

**First Half**

Answer question no. 1 and any two from the rest.

1. (a) What does an impact test indicate? 2
  - (b) Discuss the significance of impact test with relevant figures. 10
  - (c) What conclusion can be drawn from an impact test? 3
- 
2. (a) Define creep. 2
  - (b) Draw and explain two types of creep curve. 6
  - (c) Write down steady state creep equation indicating the terms. 2
- 
3. Discuss different diffusional creep with figures and equations based on Evans model. 10
  4. Explain dislocation glide creep and solute drag creep with relevant figures and equations. 10

**P.T.O.**

( 2 )

5. Write notes on any two of the following :

- (a) Dye-penetrant inspection
- (b) Magnetic-particle inspection
- (c) NDT and FATT.

### Second Half

Answer Q. No. 6 and any two from the rest.

6. Explain how tensile testing can be carried out at a constant true strain rate upto the point of fracture. Discuss various methods for the determination of strain rate sensitivity. Derive the correlation between true strain rate and engineering strain rate. Explain with relevant mathematical analysis how the high value of strain rate sensitivity promotes superplastic behavior. Suggest two experimental methods for the evaluation of activation energy for plastic flow of a material.

7. Discuss zero gage length elongation and its correlation with reduction in area at fracture for a specimen tested in tension. Comment on the geometrical factor which affects the percent elongation of a cylindrical specimen.

8. Discuss with relevant mathematical analysis how the shear stress-shear strain curve can be obtained for a cylindrical specimen by torsion testing focusing on important strength parameters.

9. Give the comparison between true stress-strain curve and the corresponding engineering stress-strain curve of a ductile material, with proper explanation. Derive the correlation between rate of strain hardening and strain

( 3 )

5×2=10

hardening exponent of a material which deforms as per Hollomon equation under tensile loading.

7+3

10. Write short notes on :

- (i) Resilience;
- (ii) Bend test;
- (iii) Engineering stress-strain curve in compression;
- (iv) Notch tensile test.

— — — —

2016-17

**TRANSPORT PHENOMENA**

**MM - 504**

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Answers of a particular group to be written sequentially.

State all assumptions clearly.

**Group A**

(Full Marks 42)

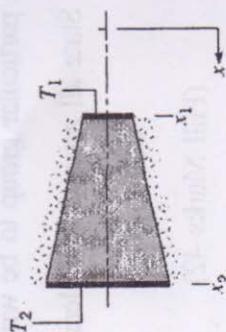
Answer any *three* questions.

1. (a) A thermocouple junction, which may be approximated as a sphere, is to be used for temperature measurement in a gas stream. The convection coefficient between the junction surface and the gas is  $h = 400 \text{ W/m}^2\text{K}$ , and the junction thermophysical properties are  $k = 20 \text{ W/m.K}$ ,  $c = 400 \text{ J/kg.K}$  and  $\rho = 8500 \text{ kg/m}^3$ . Determine the junction diameter needed for the thermocouple to have a thermal time constant ( $\tau_t = \rho c V/hA$ ) of 1s. If the junction is at 25°C and is placed in a gas stream that is at 200°C, how long will it take for the junction to reach 199°C?

10

( 2 )

- (b) What are Biot number and Fourier number? What is the physical significance of the Biot number? 4
2. (a) The diagram shows a conical section fabricated from pyroceram (thermal conductivity ( $k$ ) = 3.46 W/m.K). It is of circular cross section with the diameter  $D = \alpha x$ , where  $\alpha = 0.25$ . The small end is at  $x_1 = 50$  mm and the large end at  $x_2 = 250$  mm. The end temperatures are  $T_1 = 400$  K and  $T_2 = 600$  K, while the lateral surface is well insulated.

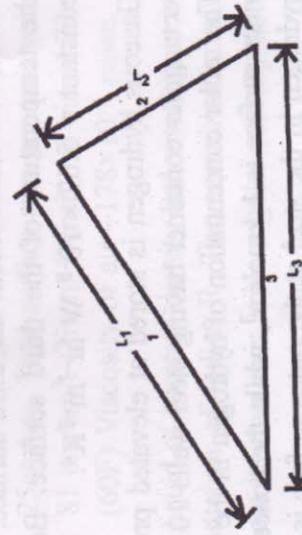


( 3 )

3. Determine the fluid temperature in the tank as a function of time. The kinetic energy, potential energy, the pressure work of the fluid and the work done on the fluid by the stirrer are negligible as compared to the thermal energy of the fluid. At inlets and outlet, heat transfer due to conduction is negligible as compared to that due to convection. 7

3. (a) A pure liquid metal at its melting temperature  $T_M$  is poured into a sand mold at the uniform temperature  $T_0$  and when mold is filled of liquid metal, the temperature of the inner surface of the mold instantaneously increase to  $T_M$  at  $t = 0$ . Determine the complete solidification time. What are the factors effecting the rate of solidification? What is heat diffusivity? What is the Chvorinov's rule? 6+2+1+1

- (b) An enclosure of triangular cross section is made up of three plane plates, each of finite width and infinite length (thus forming an infinitely long triangular prism). Derive an expression for the view factor between any two of the plate widths  $L_1, L_2, L_3$ . See figure below.



- (i) Derive an expression for the temperature distribution  $T(x)$  in symbolic form, assuming one dimensional conditions.

- (ii) Calculate the heat rate  $q_x$  through the cone.
- (b) A mixing tank receives fluid from two inlets and discharges it through one outlet. The mass of the fluid in the tank is  $M$  and its temperature  $T$  is uniform as the result of stirring. Both the tank wall and the stirrer are very light in mass and a very good in thermal insulator. As such, they can be ignored in heat flow analysis. The initial fluid mass and temperature in the tank are  $M_0$  and  $T_0$ , respectively. The mass flow rates and temperature are respectively  $m_1$  and  $T_1$  for inlet 1,  $m_2$  and  $T_2$  for inlet 2 and  $m_3$  and  $T$  for the outlet.

Figure : A triangular enclosure having sides of finite width and infinite length.

( 4 )

4. During a dialysis procedure, a patient was connected to the machine for 4 hours. The blood was pumped through the artificial kidney at the rate of 1200 mL/min. The partially cleaned blood was returned to the patient's body and wastes removed were collected in the used dialysis fluid. During the procedure, the patient's kidneys were completely inactive. A total of 1540 gm of urine was collected with a urea concentration of 1.3% by weight. A sample of the blood plasma was analyzed before the dialysis and found to contain 155.3 mg/dL of urea. The specific gravity of the plasma was 1.0245.

Blood  
Calculate (i) The urea removal efficiency by the bio-artificial Kidney. (ii) The urea concentration in the plasma of the cleaned blood, in mg/dL.

7+7

5. (a) Two large surfaces are maintained at 300 K and 400 K, respectively. Both the surfaces have an emissivity of 0.85. A third thin plate of very large dimension is placed midway between the two surfaces. This surface has an emissivity of 0.05 on both sides. Compare the heat transfer per unit area in the two cases, with and without the third surface. Determine the temperature of the third surface. Boltzmann's constant =  $5.67 \times 10^{-8} \text{ W hr}^{-1}\text{m}^{-2}\text{K}^4$ .  
10

- (b) Gaseous hydrogen is stored at elevated pressure in a rectangular container having steel walls 10 mm thick. The molar concentration of hydrogen in the steel at the inner surface is  $1 \text{ kmol/m}^3$ , while the concentration of hydrogen in the steel at the outer surface is negligible. The binary diffusion coefficient for hydrogen in steel is  $0.26 \times 10^{-12} \text{ m}^2/\text{s}$ . What is the molar diffusion flux for hydrogen through the steel?  
4

( 5 )

### Group B

(Full Marks 28)

Answer any *two* questions.

State all assumptions.

6. (a) With respect to sintering in iron making, explain the calculation of  
(i) shape of the particles  
(ii) bed height  
(iii) distance travelled by the gas  
(iv) average particle diameter.  
  
(b) What is fluidization? How is minimum fluidization velocity calculated? What are the conditions of elutriation of particles in a sulphide roaster?  
  
(c) Calculate the pressure drop, prior to ignition, across a bed of sinter 12 inches deep (void fraction : 0.39) for air flowing at 60F and with superficial velocity = 25cm/sec. Total surface area per unit volume of bed is  $81 \text{ cm}/\text{cm}^3$ . Given: Density of air  $-1.23 \times 10^{-3} \text{ g/cm}^3$ .  
(60F) Viscosity of air  $-178 \times 10^{-6}$  poise.  
  
7. A liquid of constant density and viscosity is in a cylindrical container of radius R. The container is caused to rotate about its own axis at an angular velocity  $\Omega$ . The cylinder axis is vertical so that  $g_r = 0$ ,  $g_\theta = 0$  and  $g_z = -g$ . Find the shape of the free surface of the liquid when steady state has been established.

O.T.I

( 6 )

From this derivation, find out the volume of metal required to cast a pipe of radius 50 mm, thickness 2 mm and length 1 m in centrifugal method.

Give an estimation of Hoope's stress generated in the pipe.

8. (a) A solid sphere of radius  $R$  is rotating slowly at a constant angular velocity  $\Omega$  in a large body of quiescent fluid. Develop expressions for the pressure and velocity distributions in the fluid and for the torque  $T_z$  required to maintain the motion.

(b) How is the rising velocity of bubbles calculated?

9. (a) How is the nozzle in B.O.F designed?

- (b) Explain the jet behavior in a converter with reference to centerline velocity; effective jet radius; supersonic core; impact pressure.

10. (a) Derive an equation for the overall mass balance for a reacting fluid flowing through a cylindrical reactor.

- (b) Determine the velocity of the laminar flow of an incompressible fluid of constant viscosity through a horizontal pipe of radius  $R$ . Which parameter does the relation helps to determine?

- (c) How does dimensional analysis helps to design an experiment and prototype of the actual model?

( 7 )

### THE EQUATION OF MOTION IN TERMS OF $\tau$

$$[\rho Dv / Dt = -\nabla p - [\nabla \cdot \tau] + \rho g]$$

*Cartesian coordinates ( $x, y, z$ )*

$$\begin{aligned} \rho \left( \frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial x} + v_y \frac{\partial v_x}{\partial y} + v_z \frac{\partial v_x}{\partial z} \right) &= -\frac{\partial p}{\partial x} - \left[ \frac{\partial}{\partial x} \tau_{xx} + \frac{\partial}{\partial y} \tau_{xy} + \frac{\partial}{\partial z} \tau_{xz} \right] + \rho g_x \\ \rho \left( \frac{\partial v_y}{\partial t} + v_x \frac{\partial v_y}{\partial x} + v_y \frac{\partial v_y}{\partial y} + v_z \frac{\partial v_y}{\partial z} \right) &= -\frac{\partial p}{\partial y} - \left[ \frac{\partial}{\partial x} \tau_{xy} + \frac{\partial}{\partial y} \tau_{yy} + \frac{\partial}{\partial z} \tau_{yz} \right] + \rho g_y \\ \rho \left( \frac{\partial v_z}{\partial t} + v_x \frac{\partial v_z}{\partial x} + v_y \frac{\partial v_z}{\partial y} + v_z \frac{\partial v_z}{\partial z} \right) &= -\frac{\partial p}{\partial z} - \left[ \frac{\partial}{\partial x} \tau_{xz} + \frac{\partial}{\partial y} \tau_{yz} + \frac{\partial}{\partial z} \tau_{zz} \right] + \rho g_z \end{aligned}$$

*These equations have been written without making the assumption that  $\tau$  is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric,  $\tau_{xy}$  and  $\tau_{yx}$  may be interchanged.*

*Cylindrical coordinates ( $x, \theta, z$ )*

$$\begin{aligned} \rho \left( \frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_r}{\partial \theta} + v_z \frac{\partial v_r}{\partial z} - \frac{v_\theta^2}{r} \right) &= -\frac{\partial p}{\partial r} \\ \left[ \frac{1}{r} \frac{\partial}{\partial r} (r v_r) + \frac{1}{r} \frac{\partial}{\partial \theta} \tau_{\theta\theta} + \frac{\partial}{\partial z} \tau_{rz} - \frac{\tau_{\theta\theta}}{r} \right] + \rho g_r & \\ \rho \left( \frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_\theta}{\partial \theta} + v_z \frac{\partial v_\theta}{\partial z} + \frac{v_r v_\theta}{r} \right) &= -\frac{1}{r} \frac{\partial p}{\partial \theta} \\ \left[ \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \tau_{r\theta}) + \frac{1}{r} \frac{\partial}{\partial \theta} \tau_{\theta\theta} + \frac{\partial}{\partial z} \tau_{rz} + \frac{\tau_{\theta\theta} - \tau_{r\theta}}{r} \right] + \rho g_\theta & \\ \rho \left( \frac{\partial v_z}{\partial t} + v_r \frac{\partial v_z}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_z}{\partial \theta} + v_z \frac{\partial v_z}{\partial z} \right) &= -\frac{\partial p}{\partial z} \end{aligned}$$

P.T.O.

( 8 )

$$\left[ \frac{1}{r} \frac{\partial}{\partial r} (\tau_{rr}) + \frac{1}{r} \frac{\partial}{\partial \theta} \tau_{\theta\theta} + \frac{\partial}{\partial z} \tau_{zz} \right] + \rho g_z$$

These equations have been written without making the assumption that  $\tau$  is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric,  $\tau_{r\theta} - \tau_{\theta r} = 0$ .

Spherical coordinates  $(r, \theta, \phi)$ :

$$\rho \left( \frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_r}{\partial \theta} + \frac{v_\phi}{r \sin \theta} \frac{\partial v_r}{\partial \phi} - \frac{v_\theta^2 + v_\phi^2}{r} \right) = - \frac{\partial p}{\partial r}$$

$$- \left( \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \tau_{rr}) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\tau_{\theta\theta} \sin \theta) + \frac{1}{r} \frac{\partial}{\partial \phi} \tau_{\phi\phi} - \frac{\tau_{\theta\theta} + \tau_{\phi\phi}}{r} \right) + \rho g_r$$

$$\rho \left( \frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_\theta}{\partial \theta} + \frac{v_\phi}{r \sin \theta} \frac{\partial v_\theta}{\partial \phi} + \frac{v_r v_\theta - v_\phi^2 \cot \theta}{r} \right) = - \frac{1}{r} \frac{\partial p}{\partial \theta}$$

$$- \left( \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \tau_{r\theta}) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\tau_{\theta\theta} \sin \theta) + \frac{1}{r} \frac{\partial}{\partial \phi} \tau_{\phi\theta} + \frac{(\tau_{\theta\theta} + \tau_{r\theta}) - \tau_{\phi\phi} \cot \theta}{r} \right) + \rho g_\theta$$

$$\rho \left( \frac{\partial v_\phi}{\partial t} + v_r \frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_\phi}{\partial \theta} + \frac{v_\phi}{r \sin \theta} \frac{\partial v_\phi}{\partial \phi} - \frac{v_\phi v_r + v_\theta v_\phi \cot \theta}{r} \right) = - \frac{1}{r \sin \theta} \frac{\partial p}{\partial \phi}$$

$$- \left( \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \tau_{r\phi}) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\tau_{\theta\phi} \sin \theta) + \frac{1}{r} \frac{\partial}{\partial \phi} \tau_{\phi\phi} + \frac{(\tau_{\phi\phi} - \tau_{r\phi}) + \tau_{\theta\theta} \cot \theta}{r} \right) + \rho g_\phi$$

### EQUATION OF MOTION FOR A NEWTONIAN FLUID WITH CONSTANT $\rho$ AND $\mu$

$$[\rho Dv / Dt = -\nabla p + \mu \nabla^2 v + \rho g]$$

Cartesian coordinates  $(x, y, z)$ :

$$\rho \left( \frac{\partial v_z}{\partial t} + v_x \frac{\partial v_z}{\partial x} + v_y \frac{\partial v_z}{\partial y} + v_z \frac{\partial v_z}{\partial z} \right) = - \frac{\partial p}{\partial x} - \mu \left[ \frac{\partial^2 v_x}{\partial x^2} + \frac{\partial^2 v_z}{\partial y^2} + \frac{\partial^2 v_z}{\partial z^2} \right] + \rho g_x$$

$$\rho \left( \frac{\partial v_y}{\partial t} + v_x \frac{\partial v_y}{\partial x} + v_y \frac{\partial v_y}{\partial y} + v_z \frac{\partial v_y}{\partial z} \right) = - \frac{\partial p}{\partial y} + \mu \left[ \frac{\partial^2 v_y}{\partial x^2} + \frac{\partial^2 v_y}{\partial y^2} + \frac{\partial^2 v_y}{\partial z^2} \right] + \rho g_y$$

$$\rho \left( \frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial x} + v_y \frac{\partial v_x}{\partial y} + v_z \frac{\partial v_x}{\partial z} \right) = - \frac{\partial p}{\partial z} + \mu \left[ \frac{\partial^2 v_x}{\partial x^2} + \frac{\partial^2 v_x}{\partial y^2} + \frac{\partial^2 v_x}{\partial z^2} \right] + \rho g_z$$

Cylindrical coordinates  $(r, \theta, z)$ :

$$\rho \left( \frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_r}{\partial \theta} + v_z \frac{\partial v_r}{\partial z} - \frac{v_\theta^2}{r} \right) =$$

$$- \frac{\partial p}{\partial r} + \mu \left[ \frac{\partial}{\partial r} \left( \frac{1}{r} \frac{\partial}{\partial r} (r v_r) \right) + \frac{1}{r^2} \frac{\partial^2 v_r}{\partial \theta^2} + \frac{\partial^2 v_r}{\partial z^2} - \frac{2}{r^2} \frac{\partial v_\theta}{\partial \theta} \right] + \rho g_r$$

$$\rho \left( \frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_\theta}{\partial \theta} + v_z \frac{\partial v_\theta}{\partial z} + \frac{v_r v_\theta}{r} \right) =$$

$$- \frac{1}{r} \frac{\partial p}{\partial \theta} + \mu \left[ \left( \frac{1}{r^2} \frac{\partial}{\partial \theta} (r v_\theta) \right) + \frac{1}{r^2} \frac{\partial^2 v_\theta}{\partial r^2} + \frac{\partial^2 v_\theta}{\partial z^2} - \frac{2}{r^2} \frac{\partial v_r}{\partial r} \right] + \rho g_\theta$$

$$\rho \left( \frac{\partial v_z}{\partial t} + v_r \frac{\partial v_z}{\partial r} + v_\theta \frac{\partial v_z}{\partial \theta} + v_z \frac{\partial v_z}{\partial z} \right) =$$

P.T.O.

These equations have been written without making the assumption that  $\tau$  is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric,  $\tau_{r\theta} - \tau_{\theta r} = 0$

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$$-\frac{\partial \Phi}{\partial z} + \mu \left[ \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial v_z}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 v_z}{\partial \theta^2} + \frac{\partial^2 v_z}{\partial z^2} \right] + \rho g_z$$

Spherical coordinates  $(r, \theta, \phi)$ :

$$\begin{aligned} & \rho \left( \frac{\partial v_r}{\partial r} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_r}{\partial \theta} + \frac{v_\phi}{r \sin \theta} \frac{\partial v_r}{\partial \phi} - \frac{v_\theta^2 + v_\phi^2}{r} \right) = - \frac{\partial \Phi}{\partial r} \\ & + \mu \left[ \frac{1}{r^2} \frac{\partial^2}{\partial r^2} (r^2 v_r) + \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \left( \sin \theta \frac{\partial v_r}{\partial \theta} \right) + \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2 v_r}{\partial \phi^2} \right] + \rho g_r \end{aligned}$$

$$\rho \left( \frac{\partial v_\theta}{\partial r} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_\theta}{\partial \theta} + \frac{v_\phi}{r \sin \theta} \frac{\partial v_\theta}{\partial \phi} + \frac{v_r v_\theta - v_\phi^2 \cot \theta}{r} \right) = - \frac{1}{r} \frac{\partial \Phi}{\partial \theta}$$

$$+ \mu \left[ \frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 \frac{\partial v_\theta}{\partial r} \right) + \frac{1}{r^2} \frac{\partial}{\partial \theta} \left( \frac{1}{\sin \theta} \frac{\partial v_\theta}{\partial \theta} (\theta \sin \theta) \right) - \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2 v_\theta}{\partial \phi^2} + \frac{2}{r^2} \frac{\partial v_r}{\partial \phi} - \frac{2 \cot \theta \frac{\partial v_\phi}{\partial \phi}}{r^2 \sin \theta} \right] + \rho g_\theta$$

$$\rho \left( \frac{\partial v_\phi}{\partial r} + v_r \frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r} \frac{\partial v_\phi}{\partial \theta} + \frac{v_\phi}{r \sin \theta} \frac{\partial v_\phi}{\partial \phi} + \frac{v_\phi v_r + v_\theta v_\phi \cot \theta}{r} \right) = - \frac{1}{r \sin \theta} \frac{\partial \Phi}{\partial \phi}$$

$$+ \mu \left[ \frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 \frac{\partial v_\phi}{\partial r} \right) + \frac{1}{r^2} \frac{\partial}{\partial \theta} \left( \frac{1}{\sin \theta} \frac{\partial v_\phi}{\partial \theta} (\theta \sin \theta) \right) + \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2 v_\phi}{\partial \phi^2} + \frac{2}{r^2 \sin \theta} \frac{\partial v_r}{\partial \phi} + \frac{2 \cot \theta \frac{\partial v_\theta}{\partial \phi}}{r^2 \sin \theta} \right] + \rho g_\phi$$

( 11 )

## THE EQUATION OF CONTINUITY

$$[\partial \rho / \partial t + (\nabla \cdot \rho v) = 0]$$

Cartesian coordinates  $(x, y, z)$ :

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x} (\rho v_x) + \frac{\partial}{\partial y} (\rho v_y) + \frac{\partial}{\partial z} (\rho v_z) = 0$$

Cylindrical coordinates  $(r, \theta, z)$ :

$$\frac{\partial \rho}{\partial t} + \frac{1}{r} \frac{\partial}{\partial r} (\rho v_r) + \frac{1}{r} \frac{\partial}{\partial \theta} (\rho v_\theta) + \frac{\partial}{\partial z} (\rho v_z) = 0$$

Spherical coordinates  $(r, \theta, \phi)$ :

$$\frac{\partial \rho}{\partial t} + \frac{1}{r^2} \frac{\partial}{\partial r} (\rho r^2 v_r) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \theta} (\rho v_\theta \sin \theta) + \frac{1}{r \sin \theta} \frac{\partial}{\partial \phi} (\rho v_\phi) = 0$$

\* When the fluid is assumed to have constant mass density  $\rho$ , the equation simplifies to  $(\nabla \cdot v) = 0$ .

003

Q. No. MM - 541 /

B. Tech./Odd  
2016-17/Reg

2016-17

**BASIC MANUFACTURING PROCESS**

**MM - 541**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

Answer any five questions.

1. (a) Tree structure classification of Materials. Differentiate them in terms of structure, properties and application.  
(b) Draw Fe-Fe<sub>3</sub>C phase diagram and label the phase fields. Discuss in brief the different invariant reactions in this system.  
(c) Explain Polymorphism and Allotropy.
- 2 (a) What is Investment casting ? Explain the various steps involved in Investment Casting of metals, advantages, disadvantages and its applications.  
(b) Write short notes on annealing and normalizing of carbon steels.  
(c) Why the pattern is different from casting?
- 3 (a) Write done classification of castings defects. Explain with neat sketches the following defects in casting and suggest remedies :
  - (i) Blowholes

( 2 )

- (ii) Metal penetration
  - (iii) Hot tear
  - (iv) Shrinkage Cavity
- (b) What are the general advantage, disadvantage and applications of die casting ?

(c) Differentiate between steel and cast iron. 8+4+2

4 (a) Differentiate among the primary, secondary, joining and surface finishing operations in usual terms.

(b) Explain the properties and applications of

- (i) Wrought Iron
- (ii) Plain Carbon Steel and

(iii) Cast iron

(c) Differentiate between metal and non metals. 6+6+2

5. (a) Explain the following

- (i) Ductile fracture
- (ii) Brittle fracture
- (iii) Creep
- (iv) Fatigue ?

(b) Plot the true stress-strain curves and compare with engineering stress-strain curves.

(c) Explain the effect of temperature and strain rate on plastic deformation. 8+2+4

( 3 )

6. (a) Classify metal working processes on the basis of the type of forced applied to the work piece.
- (b) Differentiate between hot working and cold working processes.

(c) A 13 mm diameter tensile specimen has a 50 mm gauge length. The load corresponding to the 0.2 percentage offset is 6800 kg and the maximum load is 8400 kg. Fracture occurs at 7300 kg. The diameter after fracture is 8 mm and the gauge length at fracture is 65 mm. Calculate the following properties of the materials from the tensile test.

- (i) Ultimate tensile strength
- (ii) Yield strength
- (iii) Breaking strength
- (iv) Percentage of elongation
- (v) Reduction of area

7 (a) Using neat sketches specify the various forging operations. 4+4+6

(b) Differentiate among welding, brazing and soldering on the basis of principles, heating ranges, major types, set ups, strength of joints and applications.

(c) Write the different tools used in Forging Operation.

6+6+2

4  $\frac{2}{3} \times 3$

8. Write short notes on any three :

- (a) Copper and its alloys

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003

Q. No. MM - 541 /

B. Tech./Odd  
2016-17/Reg

2016-17

### BASIC MANUFACTURING PROCESS

MM - 541

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

Answer any five questions.

1. (a) Tree structure classification of Materials. Differentiate them in terms of structure, properties and application.  
(b) Draw Fe-Fe<sub>3</sub>C phase diagram and label the phase fields. Discuss in brief the different invariant reactions in this system.  
(c) Explain Polymorphism and Allotropy. 6+6+2
- 2 (a) What is Investment casting ? Explain the various steps involved in Investment Casting of metals, advantages, disadvantages and its applications.  
(b) Write short notes on annealing and normalizing of carbon steels.  
(c) Why the pattern is different from casting? 8+4+2
- 3 (a) Write done classification of castings defects. Explain with neat sketches the following defects in casting and suggest remedies :
  - (i) Blowholes

**Q. No. PH - 543 / 009**

**B. Tech./Odd  
2016-17/Reg**

**2016-17**

**THIN-FILM TECHNOLOGY**

**PH - 543**

**Full Marks : 70**

**Time : Three Hours**

*The figures in the margin indicate full marks.*

*Answer any five questions.*

1. Describe XRD technique for the crystal structure determination of material. Describe the working principle of GXRD for thin film crystal structure determination. How  $\text{SiO}_2$  thin film can be grown by CVD method ? **6+2+6**
2. Describe PL technique for determination of band gap of material. Write down other applications of the technique. Discuss the optical absorption process for the determination of band to band transition in the material. How the inter band transitions can be obtained from the process ? **6+2+4+2**
3. Describe the technique for determination of chemical compositions of material by EDAX. Discuss the construction of SEM instrument and working principle of SEM. **5+4+5**
4. Describe about TEM instrument. How we can determine the crystal structure of materials by TEM ? What are the advantages of AFM over SEM? **5+5+4**

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5. Short note : (i) AFM (ii) STM. Describe Hall measurement and method of determination of type of doping in semiconductor.  
5+5+4
  6. Describe photocurrent measurement of a Schottky diode. Write down working principle of solar cell and establish the formula for external quantum efficiency.  
7+7
-

Q. No. XE - 541 / 051

B. Tech/Odd  
2016-17/Reg

2016-17

**LEADERSHIP AND ENTREPRENEURSHIP**

(Open Elective - I)

XE - 541

Full Marks : 70

Time : Three Hours

*The figures in the margin indicate full marks.*

1. Answer any two :

$$5 \times 2 = 10$$

- (a) Is leadership a trait which can be thrust from outside on a person? Can a common man acquire this trait in any circumstance? Explain with some examples.
- (b) How does communication helps to grow a leader? Time is considered to be a stress-elaborate how time management plays a role in the life of a leader. The various states of mind controls human action: illustrate with examples.
- (c) Explain the characteristics of leadership with the example of *dabbawalas* of Mumbai. Explain the role of ethics and discipline in grooming up as a leader.

2. Answer any three :

$$5 \times 3 = 15$$

- (a) What are the three strategic options available to small companies? Under what conditions is each most successful? "Our customers don't just like our ice cream" write Sudipta, founders of Kamal Ice cream; "They like

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what our company stands for. They like how doing business with us makes them feel." What do they mean?

- (b) Outline the steps involved in developing a cash budget. What steps can entrepreneurs take to conserve the cash within their companies? What should be a small business owner's primary concern when investing surplus cash?

- (c) Explain the difference in creativity and innovation. How do they help entrepreneurs to grow?

Your dinner guest are to arrive in five minutes, and you've just discovered that you forgot to chill the wine! Wanting to maintain your reputation as the perfect host or hostess, you must tackle this problem with maximum creativity. What could you do? Generate as many solutions as you can. A major maker of breakfast cereals was about to introduce a new multigrain cereal. Its principal selling point is that it features "three great tastes" in every bowl : corn, rice and wheat. Because a cereal's name is an integral part of its marketing campaign, the company hired a costly consulting firm to come up with the right name for the new product. The consulting firm tackled the job using "a combination of structural linguistics and personal creativity". List name that you think would be appropriate for this cereal.

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connection with its customers, as well as from increased confidence that it will stand behind its products." Do you agree? Explain. If so, describe a positive service experience you have had with a company and your impressions of that business. What are the implications of a company providing poor customer service? Once again, describe a negative service experience you have had with a company and your impressions of that business. How likely are you to do business with that company again?

What is the concept of the marketing Mix?

3. Analyse the following case studies and answer the questions that follow : (any three)  
 $7 \times 3 = 21$

- (a) When St. Petersburg, one of the most splendid, harmonious cities in Europe, was being laid out early in the eighteenth century, many large boulders brought by a glacier from Finland had to be removed. One particularly large rock was in the path of one of the principal avenues that had been planned, and bids were solicited for its removal. The bids submitted were very high. This was understandable, because at that time modern equipment did not exist and there were no high-powered explosives. As officials pondered what to do, a peasant presented himself and offered to get rid of the boulder for a much lower price than those submitted by other bidders. Since they had nothing to lose, officials gave the job to the peasant.

The next morning he showed up with a crowd of other peasants carrying shovels. They began digging a huge

- (d) Summarize the advantages and disadvantages of the following advertising media : directories; trade shows; sponsorships and promotions. How does the pricing of a service can be carried out? What are the principles?  
(e) One manager says, "When a company provides great service, its reputation benefits from a stronger emotional

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hole next to the rock. They propped up the rock with timbers to prevent it from rolling into the hole. When the hole was deep enough, the timber props were removed and the rock dropped into the hole below the street level. Then they covered it with dirt and carted the excess dirt away.

It's an early example of what creative thinking can do to solve a problem. The unsuccessful bidders only thought about moving the rock from one place to another on the city's surface. The peasant looked at the problem from another angle. He considered another dimension—up and down. He couldn't lift it up, so he put it underground !

Managers at the Cleveland Museum used a similar kind of creative thinking to ensure the success of a dazzling exhibit of ancient Egyptian treasures. Taking a different marketing approach, museum managers held a free private showing for the city's taxi drivers. Some of the museum's snooty, blue-blooded patrons scoffed at the idea and dismissed it as an exercise in foolishness. After all, they said, taxi drivers aren't known for their polish or their culture. But the museum managers persisted. Impress the cab drivers, they reasoned, and the "cabbies" would be more likely to recommend the new exhibit to their customers, who would, in turn, flock to the museum. That's exactly what happened. During the exhibit's run in Cleveland, the museum enjoyed shoulder-to-shoulder attendance, thanks to talkative cab drivers and creative museum managers !

The principal at one Oregon middle school used creativity to solve a maintenance problem. Girls would

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put on lipstick in the bathrooms and then press their lips to the mirror, leaving dozens of sticky lip prints that the maintenance crew had to scrub off. The principal invited all of the girls to the bathroom, where she explained the problem and the time and cost associated with cleaning the mirrors every day. She then asked the maintenance man to demonstrate how difficult it was to scrub off the lipstick. He took out a long-handled squeegee, dipped it in a toilet, and proceeded to clean the mirror with it. Since then, no lip prints have appeared on the mirrors in the girls' bathrooms !

*Question :*

Explain the study in respect of entrepreneurship.

- (b) When 25-year-old Willis Carrier invented the air conditioner in 1902, he originally did not intend it to make humans more comfortable. Instead, he saw practical application for his device in manufacturing operations that needed to control heat and humidity. Carrier's first customer was a frustrated printer whose presses turned out blurry color images because the heat and humidity in the plant caused the paper's dimensions to change, which misaligned the colored inks. Other early adopters included a textile mill in Belmont, North Carolina, that had problems with the heat generated by the weaving process that made its cotton yarns fuzzy and hard to weave and a candy maker whose chocolate melted in the summer.

In 1922, the Carrier Engineering Company, which Carrier and six friends formed in 1915 with \$32,600

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they scraped together, developed the centrifugal chiller, the first practical method of air conditioning large spaces. It wasn't until 1924 that Carrier began to market the centrifugal chiller for applications other than manufacturing. The company's first customer of air conditioning for human comfort was the J. L. Hudson Department Store in Detroit, Michigan. The store was famous for its bargain sales in the basement of its building and for the many shoppers who fainted as the heat from the throng of customers overwhelmed the crude ventilation system. The store's basement sales became even more popular after Carrier's air-conditioning system cooled the basement—and soon the rest of the store as well. Air conditioning caught on among the general public after the owner of three Houston movie theaters installed units, enabling patrons to enjoy a respite from the sweltering summer heat. Soon theaters nationwide adopted the idea, often advertising "Air Conditioning" in bigger letters on their marquees than the name of the movie! Government buildings began to install air conditioning, including the House of Representatives in 1928, the Senate in 1929, the White House in 1930, and the U.S. Supreme Court in 1931. It wasn't until after World War II that sales of small units designed for homes took off.

Throughout the 1950s, Carrier air conditioners became smaller and more powerful, opening new markets for cooling train cars, buses, ocean liner, and even cars. Carrier units were used to cool a special travelling display for Gargantua, a large gorilla that attracted huge audiences throughout Europe and the United States. Today, Carrier systems control the climate in the Sistine Chapel, the Library of Congress, and George

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Washington's historic Mount Vernon home as well as in millions of homes, factories and businesses.

The company's first foreign sale was to a Japanese silk factory in 1907. Today the company sells its air-conditioning products in more than 171 countries around the globe and generates sales of \$9 billion a year. Like many entrepreneurs throughout history, Willis Carrier could not have predicted the impact that his small company would have on the world when the idea for air conditioning hit him as he stood on a chilly, fog-shrouded platform waiting for a train. Yet, like many entrepreneurs, the world was never the same because of his ideas and his business. Gerald Davis, current president of Carrier Corporation says, "A humble but determined man, he truly changed the way we work and live."

Questions :

- (i) Was launching a business and easier in Willis Carrier's day than it is today? Explain.
- (ii) Explain how Willis Carrier exhibited the entrepreneurial spirit.
- (iii) Develop a list of other entrepreneurs whose products, services, or business changed the world. Select one that interests you and prepare a short report on him or her.
- (c) When she was in college, Candace Vanice was a french fry fanatic, but she worried about the fat content of fries cooked the traditional way. "I waited and waited for someone to create fat-free french fries, but

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no one did,” recalls Vanice. “So, I got busy in my own kitchen. I explored a great number of approaches that did not work, but one recipe showed great promise.” That recipe was based on her mother’s recipe for crispy french toast, a dish Vanice had enjoyed while growing up. After much experimenting with seasonings, Vanice created french fries that tasted as good as the ones at fast-food restaurants but with one major advantage. They contained no fat !

In 1994, Vanice applied for and received a patent for her fat-free fries, and she launched a company, Marvel LLC, to market them. She quickly learned the breaking into the food business and getting a new product on grocers’ shelves is no easy task. To gain widespread acceptance in supermarkets, a new product needs a food broker to push it. The problem 27-years old Vanice faced was that both food brokers and super-markets are reluctant to carry products that are not supported by big-time marketing and advertising campaigns. Vanice’s company, like most fledgling start-ups, did not have the financial resources to launch an extensive advertising program.

Vanice had faith in her product, however, and believed that customers would flock to buy her fat-free fries once they tasted them. She contacted several supermarkets in her hometown of Kansas City and started handing out free samples. She also hired a sampling agency to give away free product samples in stores in the surrounding area. As Vanice and the sampling agency handed out fries, they collected customer feedback, asking people to fill out surveys about the fries. According to customers, her fries were an

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overwhelming hit ! The only remaining question was how to raise the visibility of 8th Wonder Fat Free Fries enough to convince food brokers and supermarkets to carry them. That would be a challenge because Marvel LLC had practically no money for advertising.

*Question :*

- (i) Develop a creative advertising and promotional plan for Marvel LLC. What unique selling proposition should Vanice use ?
- (ii) How should Vanice use publicity to draw attention to her 8th Wonder Fat Free Fries ?
- (iii) According to one marketing expert, “A product can be copied or imitated, but a brand cannot”. What can entrepreneurs such as Candace Vanice do to build brand name recognition when they do not have the advertising budgets large companies have ?
- (d) ‘I’ll never make that mistake again,’ Douglas Martinez said to himself as he got into his car. Martinez had just left a meeting with his banker, who had not been optimistic about the chances of Martinez’s plumbing supply company getting the loan it needed. “I should have been better prepared for the meeting,” he muttered, knowing that he could be angry only at himself. “That consultant at the Small Business Development Center (SBDC) was right. Bankers’ primary concern when making loans is cash flow.”

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"At least I salvaged the meeting by telling him I wasn't ready to officially apply for a loan yet." Martinez thought. "But I've got a lot of work to do. I've got a week to figure out how to put together a cash budget to supplement my loan application. May be that consultant can help me."

When he returned to his office, Martinez gathered up the file folders containing all of his fast-growing company's financial reports and printed his projected revenues and expenses using his computer spreadsheet. Then he called the SBDC consultant he had worked with when he was launching his company and explained the situation. When he arrived at the consultant's office that afternoon, they started organizing the information. Here is what they came up with :

|                               |   |                                                                                                                                                  |
|-------------------------------|---|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Current cash balance          | : | \$8,750                                                                                                                                          |
| Sales pattern                 | : | 71% on credit and 29% in cash                                                                                                                    |
| Collections of credit sales : |   | 68% in the same month as the sale; 19% in the first month after the sale; 7% in the second month after the sale; 6% never collected (bad debts). |
| Sales forecasts :             |   |                                                                                                                                                  |
| July (actual)                 | — | \$18,750                                                                                                                                         |
| August (actual)               | — | \$19,200                                                                                                                                         |

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|                    |          |          |
|--------------------|----------|----------|
| September (actual) | —        | \$17,840 |
| October            | \$15,000 | \$17,500 |
| November           | \$14,000 | \$16,500 |
| December           | \$11,200 | \$13,000 |
| January            | \$ 9,900 | \$12,500 |
| February           | \$10,500 | \$13,800 |
| March              | \$13,500 | \$17,500 |

|                                                                            |                   |
|----------------------------------------------------------------------------|-------------------|
| Utilities expenses                                                         | \$ 800 per month  |
| Rent                                                                       | \$1,200 per month |
| Truck loan                                                                 | \$ 317 per month  |
| The company's wages and salaries (including payroll taxes) estimates are : |                   |
| October                                                                    | \$2,050           |
| November                                                                   | \$1,825           |
| December                                                                   | \$1,725           |
| January                                                                    | \$1,725           |
| February                                                                   | \$1,950           |
| March                                                                      | \$2,425           |

The company pays 63 per cent of the sales price for the inventory it purchases, as amount that it actually pays in the following month. (Martinez has negotiated "net 30" credit terms with his suppliers.)

|                 | Pessimistic | Most Likely | Optimistic |
|-----------------|-------------|-------------|------------|
| July (actual)   | —           | \$18,750    | —          |
| August (actual) | —           | \$19,200    | —          |

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Other expenses include :

|                           |                                        |
|---------------------------|----------------------------------------|
| Insurance premiums        | \$1,200 payable in August and February |
| Office supplies           | \$95 per month                         |
| Maintenance               | \$75 per month                         |
| Computer supplies         | \$75 per month                         |
| Advertising               | \$550 per month                        |
| Legal and accounting fees | \$250 per month                        |
| Miscellaneous expenses    | \$60 per month                         |

A tax payment of \$1,400 is due in December.  
Martinez has established a minimum cash balance of \$2,000.

"Well, what do you think?" Martinez asked the consultant.

Questions :

- (i) Assume the role of the SBDC consultant and help Martinez put together a cash budget for the six months beginning in October.
- (ii) What conclusions can you draw about Martinez's business from this cash budget?
- (iii) What suggestions can you make to help Martinez improve his company's cash flow?
- (e) Kerry Pinella, a recent business graduate of a small private college, started her career working for a large multinational computer software market as a sales representative. After two years in sales, Kerry applied

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for a position on a development team that was working on software applications for the World Wide Web. Kerry thrived on the team atmosphere and learned the technical aspects of the new assignment very quickly. Not only did her team bring their project in on budget, but it also completed it slightly ahead of schedule. Team members give much of the credit for the project's success to Kerry's unofficial role as team leader. Her work ethic and relentless pursuit of quality inspired other team members.

After Kerry's team completed their project, however, Kerry had a hard time recapturing the thrill and excitement of developing the World Wide Web software. Subsequent projects simply could not measure up to the "magic" of that first assignment. After talking with several of the members of that software team, Kerry discovered that they felt the same way. Before long, Kerry and two of her former team members left the company to launch their own computer consulting company, Web Consultants. Having worked on the forefront of the Web's commercialization, Kerry and her partners saw the potential it had for revolutionizing business. Their company would specialize in developing, designing, and maintaining Web sites for clients. In their first year of business, Web Consultants accepted jobs from virtually anybody who wanted a website. Although they experienced some "growing pains," Web Consultants quickly earned a reputation for producing quality work on time and was more selective in the jobs it bid on.

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Halfway into their second year of operation, the partners planned a weekend retreat at a nearby resort so they could get away, review their progress, and plan for the future. As they reviewed their latest financial statements, one of the questions that kept popping up dealt with pricing. Were Web Consultants' pricing policies appropriate? Its sales were growing twice as fast as the industry average, and the company's bid-winning ratio was well above that of practically all of its competitors. For the current year, sales were up, but Web Consultants' net profits were virtually the same as they had been in their first year.

Pulling the records from a computer database for each job they had completed since founding the company, the partners and their employees had spent 22,450 hours developing projects for their clients of a total cost of \$951,207. "We were shooting for a net profit of 25 per cent on sales". Kerry reminded her partners, "but we so far, our net profit margin is just 7.7 per cent, only one-third of our target."

"May be we could increase our profits if we increased our sales," offered one partner.

The partners began to wonder if their price of \$45 per hour was appropriate. Admittedly, they had been so busy completing projects for clients that they had not kept up with what their competitors were charging. Nor had they been as diligent in analyzing their financial statements as they should have been.

As Kerry closed the cover on her laptop computer, she looked at her partners and asked, "What should Web Consultants' hourly price be?"

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Questions :

- (i) Help Kerry answer the question she has posed.
- (ii) What factors should Kerry and her partners consider when determining Web Consultants' final price?
- (iii) Is the company's current price too low? If so, what signals could have alerted Kerry and her partners?

4. Analyse the case studies and answer the questions that follow : (any three)

(a) Starts with a Bang, Ends with a Whimper

A faculty member, Kim Green from the Management Department, was asked to chair a major university committee to plan the mission of the university for the next 20 years. Three other senior faculty and seven administrators from across the campus were also asked to serve on this committee. The president of the university, Dr. Sulgrave, gave the committee its charge: What should Northcoast University be like in the year 2020? Dr. Sulgrave told the committee that the work of this task force was of utmost importance to the future of the university and the charge of this committee should take precedence over all other matters. The task force was allowed to meet in the president's conference room and use the president's secretary. The report of the committee was due in 2 months.

The task force members felt very good about being selected to such an important team. The team met on a weekly basis for about 2 hours. At first, the members

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were very interested in the task and participated enthusiastically. They were required to do a great deal of outside research and gathering of information. They would come back to the meetings proud to demonstrate and share their research and knowledge. However, after a while the meetings did not go well. The members could not seem to agree on what the charge to the group meant. They argued among themselves about what they were supposed to accomplish and resented the time the committee was taking from their regular jobs. Week after week the team met but got nothing accomplished. Attendance began to become a problem with people skipping several meetings, showing up late, or leaving early. Group members stopped working on their committee assignments. Kim Green didn't know what to do because she didn't want to admit to the university president that they didn't know what they were doing. She just got more and more frustrated. Meetings became sporadic and eventually stopped altogether. The president was involved in a crisis in the university and seemed to lose interest in Kim Green's Committee. The president never called for the report from the committee and the report was never completed.

*Questions :*

- (i) Which characteristics of excellence were lacking in this task force ?
- (ii) Which characteristics of excellence were evident in this task force ?
- (iii) How would you assess Kim Green as a leader ?
- (iv) What actions would you take (internally/externally) if you were the leader of this task force ?

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(b) Can This Virtual Team Work ?

Jim Towne heads up a newly formed information technology team for a major international corporation. The team is composed of about 20 professionals who live and work in Canada, the United States, Europe, South America, Africa and Australia. All members of the team report to Jim Towne. The team is a virtual team and is connected primarily using technology (videoconference, group decision support ware, e-mail and telephone). The team has met twice in a face-to-face setting to set goals and plan. All of the team members are quite competent technically in their respective areas. Some team members have a long and valued history with the company; others have recently become members of the company through a corporate merger. The team members have never worked together on any projects previously.

The task of the team is to develop and implement new technology innovations for all of the business units of the corporation globally. The team is excited about the importance and the innovative nature of their assignment. They respect each other and enjoy being part of this team. However, the team is having difficulty getting off the ground and the members report being extremely overloaded. Most team members travel to business sites at least 2 weeks each month. The travel is important, but it causes team members to get farther and farther behind.

There is one half-time secretary for the team, located in New York. Her responsibility is primarily to organize travel

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and meetings of team members. Team members are working on several projects at once and have great difficulty finishing any of the projects. One team member has 500 e-mail messages that have yet to be read because each team member sends copies of all messages to everyone on the team. Jim Towne feels under great pressure to prove that this team can work and provide a valuable function to the organization.

*Questions :*

- (i) Which of the characteristics of team excellence are lacking in this team ?
- (ii) At what level(s) should Jim Towne intervene to improve this team (internal task, internal relation, external) ? Or should he just keep monitoring the team and not intervene ?
- (iii) What specific leadership functions should Jim Towne implement to improve the team ?
- (c) They Dominated the Conversation

The local cancer center has a health team designed to coordinate the care of children with cancer. The team is composed of a physician, Dr. Sherif Hidayat (a clinical oncologist); a radiologist, Dr. Wayne Linett; a nurse practitioner, Sharon Whittington; a social worker, Cathy Ing; a physical therapist, Nancy Crosby; and a child life worker, Janet Lewis. The team members meet on a weekly basis to discuss the 18 children under their care and to come to agreement about the best course of treatment for each child. Cathy Ing, the social worker, is the head of the team and is responsible for the case management of each child. However, when the team meets

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Drs. Hidayat and Linett dominate the conversation. They feel that their medical background gives them greater knowledge and skill in the treating of cancer in children. They welcome input from the women in the group; however, when it comes to making a decision, they insist on doing it their way for the good of the patient. The social worker, the child life worker, the physical therapist and the nurse resent this behavior because they are the ones that spend the most time with the children and feel that they know best how to handle their long-term care. The group effectiveness or outcomes of this group are such that the patients feel no one cares or understands them. The team is also having trouble working together and no one on the team is feeling satisfied with the outcome.

*Questions :*

- (i) How would you assess the effectiveness of this team both in terms of performance and development ?
- (ii) In monitoring this team, at what level do you see the most serious problem(s) of this team ? Internal task ? Internal relational ? External ?
- (iii) Would you take action to improve team functioning ? If so, how would you choose to intervene ? Why ?
- (iv) What specific leadership skill or skills would you employ to improve group functioning ?

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(d) "But That's What I Proposed"

Lori Bradley, an experienced probation manager is meeting with Ted Stolze and Ian Bateson, two other probation managers and their supervisor, Len Duggan, the assistant chief of probation. They are planning an orientation session for new probation officers on how to prepare investigative reports for the court.

As Lori enters the room, the two other probation managers are throwing paper clips at each other and laughing about a major play in the previous night's NFL championship game. They continue talking as she enters the room, ignoring her. When Len, the assistant chief, enters, the two men include him in their talk about the game.

After a few minutes, Len says, "Okay, let's get down to business and start planning the orientation session. Any ideas?"

Lori says, "I looked again at the session prepared by Columbia County, which was described at our last meeting, and I think we should use that. It worked well for them and seems to fit our county." No one looks at Lori or responds to her, but Ted begins making some suggestions for a different idea and the others follow up with questions to him. After problems arise with Ted's suggestion, Ian then says, "My idea would be to go for the Columbia County plan; that would work best here." Len, the assistant chief, says, "Ian, I'll go with your judgement." Ted says, "Me too Great idea, Ian."

Lori breaks in, "But that's what I proposed initially and you just ignored me." Ian says, "Stop being so sensitive, Lori, We're supposed to be a team here."

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Questions :

- (i) Which advancement barriers and patterns apply to Lori's situation?
- (ii) How could Len Duggan have behaved differently to provide a role model for Lori's male colleagues?
- (iii) How could Len Duggan have run the meeting differently to improve the team's decision making and cohesion? What should Len have said after Ian made the same suggestion that Lori did?
- (iv) What could Lori do differently to increase her inclusion in the management team?
- (v) What could the organization provide to foster all four managers' effectiveness?
- (e) How Safe is Safe?

Perfect Plastics Incorporated (PPI) is a small injection molding plastics company that employs 50 people. The company is 10 years old and has a healthy balance sheet, and it is doing about \$4 million a year in sales. The company has a good safety record and the insurance company that has PPI's liability policy has not had to pay any claims to employees for several years. There have been no major injuries of any kind since the company began.

The owner takes great pride in the interior design and working conditions at PPI. He describes the interior of the plant as being like a hospital compared with his competitors. Order, efficiency, and cleanliness are top

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priorities at PPI. It is a remarkably well-organized manufacturing company.

PPI has a very unique approach to guaranteeing safe working conditions. Each year, management brings in outside consultants from the insurance industry and the Occupational Safety and Health Administration (OSHA) to audit the plant for any unsafe conditions. Each year, the inspections reveal a variety of concerns, which are then addressed through new equipment, repairs and changed work-flow designs. Although the inspectors continue to find opportunities for improvement, the overall safety improves each year.

The attorneys for PPI are very opposed to the approach to safety that the company takes. The lawyers are vehemently against the procedure of having outside auditors. If a lawsuit were to be brought against PPI, the attorneys argue that any previous issues could be used as evidence of a historical pattern and knowledge of unsafe conditions. In effect, the audits that PPI is voluntarily having conducted could be used by plaintiffs to strengthen a case against the company.

The president and management recognize the potential downside of outside audits, but they point out that the periodic reviews are critical to the ongoing improvement of the safety of everyone in the plant. The purpose of the audits is to make the shop a secure place and that is what has occurred. Management also points out that PPI employees have responded positively to the audits and to the changes that result.

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*Questions :*

- (i) As a company would you describe PPI as having an identifiable set of moral values ? How does its policies contribute to this philosophy ?
- (ii) Which ethical perspective best describes PPI's approach to safety issues ? Would you say PPI takes a utilitarian, duty, or virtue-based approach ?
- (iii) Regarding safety issues, how does management see its responsibilities toward its employees ? How do the attorneys see their responsibilities toward PPI ?
- (iv) Why does it appear that the ethics of PPI and its attorney are in conflict ?

**(f) Eating Lunch Standing Up**

Susan Parks is the part-owner and manager of Marathon Sports, an athletic store that specializes in running shoes and accessories. The store employs about 10 people, most of whom are college students who work part-time during the week and full-time on weekends. Marathon Sports is the only store of its kind in a college town with a population of 125,000. The annual sales figures for the store have shown a 15% growth for each of the past 7 years.

Ms. Parks has a lot invested in the store and she works very hard to make sure the store continues to maintain its reputation and pattern of growth. She works 50 hours a week at the store, where she wears many hats, including those of buyer, scheduler, trainer, planner and salesperson. There is never a moment when Susan is not doing something. Rumor has it that she eats her lunch standing up.

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Employees' reactions to Ms. Parks are strong and quite varied. Some people like her style and others do not. Those who like her style talk about how organized and efficient the store is when she is in charge. Susan makes the tasks and goals for everyone very clear. She keeps everyone busy and when they go home at night they feel as if they have accomplished something. They like to work for Susan because she knows what she is doing. Those who do not like her style complain that she is too driven. It seems that her sole purpose for being at the store is to get the job done. She seldom, if ever, takes a break or just hangs out with the staff. These people say Susan is pretty hard to relate to and as a result it is not much fun working at Marathon Sports.

Susan is beginning to sense that employees have a mixed reaction to her leadership style. This bothers her but she does not know what to do about it. In addition to her work at the store, Susan struggles hard to be a good spouse and mother of three children.

*Questions :*

- (i) According to the style approach, how would you describe Susan Parks's leadership ?
  - (ii) Why does it create such a pronounced reaction from her subordinates ?
  - (iii) Do you think she should change her style ?
  - (iv) Would she be effective if she changed ?
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