

9. (a) Draw a PERT network diagram with activity on node and each node should be labelled with early start (ES), early finish (EF), late start (LS), late finish (LF) & task name and assign the respective expected time values for each node. Also calculate the slack for each node and identify the critical path in the project work.
- (b) There are 7 tasks (A, B, C, D, E, F, and G) to be accomplished in an R & D project work. Each task is assigned with 3 time estimates as per the norms of PERT activities, namely optimistic time (O), most likely time (M) & pessimistic time (P) as given below:

Activity	Predecessor	Time Estimates (yrs)			Expected time (yrs)
		Optimistic (O)	Most Likely (M)	Pessimistic (P)	
A	-	2	4	6	4.00
B	-	3	5	9	5.33
C	A	4	5	7	5.17
D	A	4	6	10	6.33
E	B, C	4	5	7	5.17
F	D	3	4	8	4.5
G	E	3	5	8	5.17

**2 + 10 = 12**

**PROJECT ENGINEERING  
(CHEN 3202)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

***Figures out of the right margin indicate full marks.***

***Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.***

***Candidates are required to give answer in their own words as far as practicable.***

**Group – A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- HAZOP study, an important consideration in the plant design for engineering operations, stands for
    - Healthy Operating Parameters study
    - Hazard Analysis for operations study
    - Hazard and compatibility study
    - Health safety for men & operating equipments.
  - Working capital required in a manufacturing business is
    - Total capital - fixed capital
    - Total capital - fixed capital - land cost
    - Total capital - land cost
    - Total capital - fixed capital + land cost.
  - The salvage value of an asset becomes zero when the depreciation cost is calculated in the following the method
    - Straight-line method
    - Declining-balance method
    - Sum-of-the years-digits method
    - Sinking fund method.
  - One of the methods for profitability analysis is return on investment (ROI) which is expressed as the ratio of (Capital stands for capital investment)
    - Annual profit to fixed capital
    - Annual profit to total capital
    - Annual revenue to total capital
    - Annual revenue to fixed capital.

- (v) Matheson formula for calculation of depreciation cost fails when  
 (a) salvage value is high (c) length of service life is low  
 (b) salvage value is zero (d) length of service life is high.
- (vi) Pinch technology is implemented for energy savings in a process with hot & cold streams with the help of heat exchanger network by  
 (a) savings by heat integration  
 (b) increasing the external utility loads  
 (c) low heat exchanger design cost  
 (d) the use of any advanced unit operations.
- (vii) If the constraint of a general linear optimisation problem is of the type  $\sum_{j=1}^n a_{ij} x_j \leq b_i$ , then for expressing the constraint as equations, a non-negative variable, added to the left hand side of the equation to satisfy the equation, is called  
 (a) surplus variable (b) slack variable  
 (c) independent variable (d) decision variable.
- (viii) In an ordinary annuity plan payments are made  
 (a) at the beginning of each time interval  
 (b) at the end of each time interval  
 (c) at any time between beginning and end of each time interval  
 (d) at the mid-point between beginning and end of each time interval.
- (ix) In PERT chart network analysis, the normal deviation  $Z=0$  corresponds to  
 (a) 100% (b) 75%  
 (c) 50% (d) 25%.
- (x) The float of an activity in project network is  
 (a)  $\min (ES_{\text{successor}}) - EF$  of current activity (b)  $ES - LF$   
 (c)  $LF - EF$  (d)  $LS - ES$ .  
 [where, ES=early start, EF=early finish, LS=Late Start, LF=Late Finish].

### Group - B

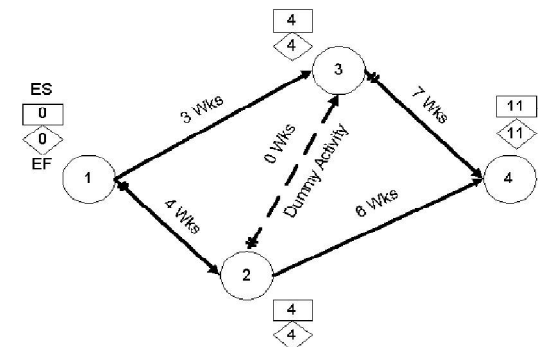
2. (a) How would you account for the benefits & utilities of a Piping & Instrumentation Diagram (P&ID) in regard to process economics and control of process parameters and operational safety in a chemical plant?
- (b) Discuss the implication of labour and materials cost on the manufacturing cost of a chemical plant.

7. (a) A company manufactures two types of paints, using three different colours of pigments. One litre of type A paint requires 400 gm of red pigment, 500 gm of green pigment and 300 gm of yellow pigment. One litre of B paint requires 500 gm of red, 200 gm of green and 800 gm of yellow pigment. The pigment available for manufacture is 90 kg of red, 90 kg of green and 120 kg of yellow pigment. The manufacturer can make a profit of Rs. 50 on one litre of type A and Rs.30 on one litre of type B paints. Find the best combination of the quantity of type A & type B paint which gives the maximum profit to the manufacturer by solving the problem in linear Programming method.
- (b) A plant produces refrigerators at the rate of P units per day. The variable costs per refrigerator have been found to be Rs.47.73 + 0.1P\*. The total daily fixed charges are Rs.1750, and all other expenses are constant at Rs.7325 per day. If the selling price per refrigerator is Rs.173, determine:  
 (i) The daily profit at a production schedule giving the minimum cost per refrigerator.  
 (ii) The daily profit at a production schedule giving the maximum daily profit.  
 (iii) The production schedule at the break-even point.

$$6 + 6 = 12$$

### Group - E

8. (a) State the Fulkerson's rule with illustrations for drawing a network of activities with the numbering sequences of the activities.
- (b) Write down the differences between PERT & CPM network of activities for completing a project.
- (c) Tabulate and analyse the various time durations for start and finish of the activities and also calculate the total float and identify the critical path as per the following network diagram.



$$3 + 3 + 6 = 12$$

- (c) Define the terms for an asset (i) Salvage value (ii) Scrap Value (iii) Book Value (iv) payback period (v) Return on investment (vi) Rate of return on investment.

**3 + 3 + 6 = 12**

3. (a) For the case of an investment of Rs.100 crores in a manufacturing business at the nominal interest rate of 20% per year, determine
- The total amount to which the said invested principal would accumulate after 1 year with monthly compounding and the effective interest rate.
  - The total amount to which the said invested principal would accumulate after 1 year with daily compounding and the effective interest rate.
  - The total amount to which the said invested principal would accumulate after 1 year with continuous compounding and the effective interest rate.
- (b) Discuss the effect of income tax on the choice of capital sources for capital investment in a new business and an established business. Write down key differences between fixed capital and working capital investment.

**5 + 3 + 4 = 12**

### Group - C

4. (a) The original value of a piece of equipment is Rs.22,00,000/-, completely installed and ready for use. Its salvage value is estimated to be Rs. 2,00,000/- at the end of a service life estimated to be 10 years. Determine the asset (or book) value of the equipment at the end of 5 years using:
- Straight-line method.
  - Textbook declining-balance method.
  - Double declining-balance (200 percent) method (i.e. the declining-balance method using a fixed-percentage factor giving a depreciation rate equivalent to twice the minimum rate with the straight-line method).
- (b) Compare by graphical representation of the straight-line, multiple straight-line, sum-of-the-years-digits, and declining-balance methods for determining depreciation.
- (c) Draw the cash flow diagram with the details by explaining the cash flow components involved in a manufacturing company.

**6 + 2 + 4 = 12**

5. (a) Show that the capitalised cost of an asset can be expressed as  $K_v = C_v + \frac{C_R}{e^{-in}-1}$ .  
If the interest is compounded continuously, where  $K_v$  = Capitalised cost,  $C_v$  = Original cost and  $C_R$  is the replacement cost,  $i$  is the annual interest rate and  $n$  is the service life, year.
- (b) Compare alternative investments details given below by different profitability methods such as (i) Rate of return on investment (ii) Payback period (iii) Discounted cash flow rate of return.

Investment No.	Total initial fixed capital investment (Rs.)	Working-capital investment (Rs.)	Salvage value at the end of service life (Rs.)	Service life, yrs.	Annual** earnings after taxes (Rs.)
1	100,000	10,000	10,000	5	See below**
2	170,000	10,000	15,000	7	42,000 (constant)
3	210,000	15,000	20,000	8	48,000 (constant)

\*\*This is total annual income minus all costs except depreciation.

\*\*For investment 1, annual earnings flow to the project are: year 1=Rs.30,000, year 2=Rs.31,000, year 3=Rs.36,000, year 4= 40,000 & year 5 = Rs. 43,000.

**6 + 6 = 12**

### Group - D

6. (a) Define Break-even point (BEP) in a business scenario for financial analysis and explain the concept of BEP with graphical presentation and purpose of it in a business operation.
- (b) A plant produces small water pumps at the rate  $P_r$  units per day. The variable cost per pump has been established to be Rs.47.73 + 0.1  $P_r^{1/2}$ . The total daily fixed charges are Rs.1750, and all other expenses are constant at Rs. 7325 per day. If the selling price per pump is Rs. 173, determine
- The daily profit at production schedule giving the minimum cost per pump
  - The daily profit at a production schedule giving the maximum daily profit.
  - The production schedule at the BEP.

**6 + 6 = 12**