B. Tech.
(SEM. VIII) EXAMINATION, 2006-07
PROCESS ENGINEERING COSTING & PLANT DESIGN

Time : 3 Hours] [Total Marks : 100

Notes :
(1) Attempt all questions.
(2) All questions carry equal marks.
(3) In case of numerical problems assume data wherever not provided.
(4) Be precise in your answer.

1. Attempt any four parts of the following : \(5 \times 4 = 20\)
   (a) Name five national and five international journals of chemical engineering.
   (b) What are the essential items those are included in the flow sheet preparation? How do you go for equipment numbering?
   (c) Discuss different steps reaching towards final plant site selection.
   (d) Provide specification list for a distillation column and a heat exchanger.
   (e) Write different components of start-up costs.
   (f) What are the legal aspects of safety in plant design?

2. Attempt any four parts of the following : \(5 \times 4 = 20\)
   (a) Find the effective rate of return if money at 8 percent per year is compounded (i) monthly (ii) continuously.

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(b) A person pays an ordinary annuity of Rs. 1,000 per year for 10 years and makes no further payments. If money is worth 10 percent per year, what is the money in the fund at the end of 15 years?

(c) A new tank costs Rs. 50,000 and lasts 5 years. An old tank can be patched now for Rs. 7,000 to give one more year of life, then for Rs. 9,500 to give another year of life, then for Rs. 12,000 to give one more year of life etc. How long should the old tank be patched if money is worth 10 percent per year?

(d) The original cost of a property is Rs. 30,000 and it is depreciated by a 6 percent sinking-fund method. What is the annual depreciation charge if the book value of the property after 10 years is the same as if it had been depreciated at Rs. 2,500 / year by the straight line method?

(e) A reactor having a negligible salvage and scrap value is estimated to have a service life of 10 years. The original cost of the equipment was Rs. 40,000. Determine the depreciation charge for the fifth year if double declining balance depreciation is used.

(f) What are the major insurance requirements for manufacturing concerns?

3. Attempt any two parts of the following: 10 × 2 = 20

(a) The following information applies to the two proposals for power plants:

<table>
<thead>
<tr>
<th></th>
<th>Boiler and Steam Turbine</th>
<th>Gas Turbine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial investment</td>
<td>6,000,000</td>
<td>4,000,000</td>
</tr>
<tr>
<td>Fuel cost Rs./year</td>
<td>160,000</td>
<td>230,000</td>
</tr>
<tr>
<td>Maintenance, Rs./year</td>
<td>120,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Insurance and taxes Per year</td>
<td>180,000</td>
<td>120,000</td>
</tr>
<tr>
<td>Service life, years</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Salvage value at end of service life</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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If 12 percent return is required on any investment, which one should be recommended?

(b) Find the payout times without interest and with interest at rate of 10 percent for the given data:

<table>
<thead>
<tr>
<th>Time end year</th>
<th>Profit after Tax Rs.</th>
<th>Depreciation Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1,00,000</td>
<td>0000</td>
</tr>
<tr>
<td>1</td>
<td>27,500</td>
<td>20,000</td>
</tr>
<tr>
<td>2</td>
<td>20,000</td>
<td>90,000</td>
</tr>
<tr>
<td>3</td>
<td>13,000</td>
<td>90,000</td>
</tr>
<tr>
<td>4</td>
<td>7,000</td>
<td>90,000</td>
</tr>
<tr>
<td>5</td>
<td>0000</td>
<td>90,000</td>
</tr>
</tbody>
</table>

(c) Give a break down of fixed - capital investment items for a chemical process plant. Discuss two methods in detail for estimating capital investment.

4. Attempt any two parts of the following: 10×2=20

(a) A plant produces refrigerators at the rate of P units per day. The variable costs per refrigerator have been found to be Rs. 5000 + 100P. The total daily fixed charges are Rs. 200,000 and all other expenses are constant at 8000,000 per day. If the selling price per refrigerator is Rs. 15,000, 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.

(b) For net sales of a company amounting to Rs. 600,000 annually, when the fixed costs are Rs. 350,000 and the direct costs are 35 percent of the net sales rupees:
   (i) What is the break-even-point in terms of sales rupees?
   (ii) What sales are required for a profit of Rs. 80,000?

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[Contd...]
(c) Clearly differentiate among cyclic, semicyclic and vario-cyclic operations giving examples.

5. Attempt any one of the following:
   (a) An evaporator shows the following variation of $U$,
       the overall heat transfer coefficient in $\frac{W}{m^2 \cdot s}$ with
       $T$ in seconds measured from the starting time with clean tubes

       $$\frac{1}{U^2} = 0.0002 \times 10^{-8} T + 8 \times 10^{-8}$$

       A cleanout costs Rs. 3,000 and causes 10 hour downtime. The allocable operating cost is Rs. 1,500
       per hour : 5,00,000 kg/day for 250 days per year must be evaporated from a 280 m$^2$ area. The latent
       heat of vaporization is $2.3 \times 10^3$ kJ/kg and the driving
       force is 28 K. Find the optimum time for operation
       before recleaning.

   (b) Write notes on any two of the following:
       (i) Optimum design of heat exchanger
       (ii) Techno-economic feasibility report
       (iii) Determination of distillation column diameter
            and height.