M.E BIOPROCESS ENGINEERING FIRST YEAR FIRST SEMESTER EXAMINATION– 2024
[FIRST YEAR FIRST SEMESTER]

BIOCHEMICAL PLANT DESIGN & ECONOMICS

Time: 3 hrs **Full Marks: 100**

(All questions carry equal marks, i.e. 20 each).

(Answer any five questions)

1. Consider the scale up of a fermenter from a 10 L to 10,000 L vessel. The small fermenter has a height-to-diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 500rpm and three Rushton impellers are used. Determine the dimensions of the large fermenter and agitator speed for:
   (a) Constant P/V
   (b) Constant impeller tip speed
   (c) Constant Reynolds number

   Assume geometric similarity.

2. Z plans to receive annuity payment of Rs. 5000 for 10 years after his retirement semi-annually. He retires 18 years from now. Current rates are 9% p.a. compounded semi-annually.
   a) What amount is required for present value of the annuity?
   b) What amount of single deposit made now will provide the amount in part (a) after 18 years.
   c) What is the total amount Z will receive from the annuity?

3. The fixed capital investment (excluding the cost of land) of a new project is estimated to be 15 MD, salvage value of the plant is 1 MD, assuming a seven year equipment life, calculate and compare yearly depreciation allowances using straight line and double declining balance method.

4. Approximately 120 M.D is available for a company to invest in a new project. There are three investment options, all with an operating life of 10 years, available at minimum acceptable internal interest rate of 10% after tax.

Available options	Initial Investment (MD)	After tax cash flow in i=1 year	After tax cash flow in i=2 to 10 year
Project A	60	10	12
Project B	125	22	22
Project C	100	12	2

   Evaluate the options using NPV (a) Zero Salvage (b) Initial investment occurs at t=0. (c)Annual cash flow occurs at the end of each 10 years of plant operation. Carry out incremental analysis.

5. There are two options available for a pump made with Carbon steel and Stainless steel with discounted interest rate of 8% per annum. Calculate ECC and EAOC and choose the better option.

Pump Option	Installed cost (in $)	AOC (in $/Yr)	Equipment Life (Yr)
CS Pump	7000	1800	4
SS Pump	12000	1600	7

6. What is Good Manufacturing Practices (GMP)? Discuss in brief the GMP cleanroom requirements for grade A, B, C and D facility.
7. Show that for a large and small scale bio reactor the ratio of aeration rate is equal to the linear scale ratio (λ). The controlling regime remains same for both type of reactors. In turbulent zone, the impeller type configuration remains same and power number is identical in both the cases.
   Given that,

$$K_{La} = A\left(\frac{P_g}{V}\right)^{\alpha} V_S{}^{\beta}$$

$$Sh = a_2 Re^{b_2} Sc^{c_2}$$

$$\frac{K_L L}{D} = a_2\left(\frac{ndeg^2\rho}{\mu}\right)^{b_2}\left(\frac{\mu}{\rho D}\right)^{c_2}$$

   Assume and state any missing data.