Complete the table and determine the economic order quantity based on the above information.

Orders per year	Lot size	Average inventory	Carrying cost (Holding cost)	Ordering cost (Setup cost)	Total cost(₹) per year
	26000				
	13000				
	2000				
	1000				
	500				
	250				

[CO1] [CO4] 2+6

★★★

B. SC. MATHEMATICS (HONS.) EXAMINATION, 2025

(2nd Year, 1st Semester)

PAPER : SEC

(MATHEMATICAL MODELLING)

Time : *Two Hours* *Full Marks* : 40

The figures in the margin indicate full marks

Symbols / Notations have their usual meanings

Answer any **five** questions

1. Suppose Layla and Majnu are emotionally connected. Assuming that the emotion is measurable, propose a simple model for the love affairs of Layla and Majnu. Under what parametric conditions are the two lovers said to be exactly opposite? Determine the stability condition of the equilibrium love levels under this situation. **[CO1][CO3]** 3+2+3

2. Suppose two nations, I and P, are engaged in an arms race. Assuming $i(t)$ and $p(t)$ as the armament levels of the nations I and P at time t, describe the rate equations of their armament levels mentioning the basic assortment of psychological and strategic motivations. What is the equilibrium defence level? Under what parametric conditions will the two nations be able to avoid instability in the arms race? **[CO1][CO3]** 3+5

3. *(a)* What do you mean by dimensional homogeneity? What will be the dimensional formula of S and T in the dimensionally homogeneous equation

$$F = \frac{S}{\text{density}} + T,$$

where F is the force?

(b) Consider the system

$$\frac{dB}{dt} = rB\left(1 - \frac{B}{K}\right) - dBP,$$
$$\frac{dP}{dt} = cdBP - mP,$$

where B and P are two species. The parameters r, K, d, c, m are all positive and c is dimensionless. Nondimensionalize the above system with suitable transformations. **[CO2]** 4+4

4. *(a)* Define Newton's law of cooling. If T_i is the initial body temperature of an object, then determine its temperature at an arbitrary time t, if the surrounding temperature is assumed to be constant as $T_s (< T_i)$.

(b) A murder victim is discovered at midnight and the temperature of the body is recorded as 31 °C. One hour later, the temperature of the body is 29 °C. Assuming that the surrounding air temperature remains constant at 21 °C, determine the victim's time of death (the normal temperature of a living human is 37 °C).

[CO1][CO3] 4+4

5. *(a)* Describe the kinetics of a second-order reaction for a single reactant.

(b) A new antibiotic drug was given in a single intravenous administration of 4 mg/kg to five healthy adults ranging in age from 23 to 38 years (average weight 75 kg). The plasma-level-time curve for this drug fits a one-compartmental model. The equation of the curve that best fits the data is $C_p = 78e^{-0{\cdot}46t}$. Determine the following (assume units for C_p as μg/ml and for t as hours) :

(i) What is the half-life of the drug?

(ii) What is the plasma level of the drug after 4 hrs?

(iii) Assuming the drug is no longer effective if the level declines to less than 2 μg/ml, when would you administer the next dose? **[CO4]** 3+5

6. *(a)* Mention some advantages and disadvantages of maintaining an inventory.

(b) The following information is given by *XYZ* company :

- Annual requirement is 26000 units.
- Cost per order is ₹ 30.
- Carrying cost per year is 20% of average inventory.
- Price per unit is ₹ 7·8.