2008

MICROBIOLOGY

PAPER—IX

Full Marks : 40

Time : 2 hours

Answer **two** questions from each Group

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

GROUP—A

[*Marks* : 20]

Answer any *two* questions

1. Answer any *four* bits : $2\frac{1}{2} \times 4$

(*a*) Evaluate

$$\lim_{x \to 0} \frac{\sqrt{1 + 2x} - \sqrt{1 - 3x}}{x}$$

(*b*) Find the value of

$$\lim_{n \to \infty} \left(\frac{1}{n^2} + \frac{2}{n^2} + \frac{3}{n^2} + \ldots + \frac{n}{n^2} \right).$$

(*c*) A function is defined as follows:

$$\varphi(x) = -x \quad \text{when} \quad x \leq 0$$

$$= x \quad \text{when} \quad 0 < x < 1$$

$$= 2 - x \quad \text{when} \quad x \geq 1$$

Show that $\varphi(x)$ is continuous at $x = 1$.

(*d*) If

$$y = \frac{\cos x - \cos 2x}{1 - \cos x},$$

find $\frac{dy}{dx}$.

(*e*) If

$$y = \sqrt{2x} - \sqrt{\frac{2}{x}} + \frac{x+4}{4-x},$$

find $\frac{dy}{dx}$ for $x = 2$.

(*f*) Integrate

$$\int \frac{a\sin^3 x + b\cos^3 x}{\sin^2 x \cos^2 x}\, dx.$$

(*g*) Evaluate

$$\int \frac{\cos x\, dx}{(a + b\sin x)^2}.$$

2. Answer any *four* bits: $2\frac{1}{2} \times 4$

(*a*) Interpret Geometrically: $\frac{dy}{dx} = 0$.

(*b*) Given $xy = 4$, find the maximum and minimum values of $4x + 9y$.

(*c*) Show that

$$f(x) = x^3 - 6x^2 + 24x + 4$$

has neither a maximum nor a minimum.

(*d*) Evaluate

$$\int_1^2 x^2 dx$$

and interpret it geometrically.

(*e*) A particle is moving in a straight line. Its distance x cm. from a fixed point O at any time t second is given by the relation

$$x = t^4 - 10t^3 + 24t^2 + 36t + 12$$

when is it moving most slowly ? (velocity is given by $\frac{dx}{dt}$).

(*f*) Obtain a mathematical model/structure for a bacterial culture undergoing balanced growth such that the rate of increase in bacteria at any particular time is proportional to the member or mass of bacteria present at that time.

3. (*a*) Find $\frac{dy}{dx}$ where $y = (x \sin x)^3$.

(*b*) Let the growth of a microorganism satisfy the differential equation

$$\frac{dP}{dt} = kP - qP, \quad k > 0$$

where $P(t)$ be the population of microorganism at time t. Let q is called dilution rate and defined by $q = Q/V$. Where V is the volume of nutrient liquid medium of a growth

chamber. Q is rate of volume per unit time supplied to the chamber. Show that $q > k$ the culture is being diluted and the population will be declined to zero. If $q < k$ the density of microorganism in the chamber will increase. 4 + 6

GROUP—B

[*Marks* : 20]

Answer any *two* questions

4. (*a*) Define correlation and regression.

(*b*) Find out regression equation of Y on X from the following data for 7 fishes of a species:

X :	13·4	15·1	15·3	16·8	17·5	19·2	21·2
Y :	2·1	2·3	2·3	2·6	2·7	3·0	3·3

4 + 6

5. (*a*) Write down the probability mass function (p.m.f.) of the Binomial distribution with parameters n and p.

(*b*) What is the probability that a family with five children will have 3 boys and 2 girls.

(*c*) Find the mean and the median of the following data:

59, 65, 71, 67, 61, 63, 69, 73

2 + 5 + 3

6. Fishes were reared in three different ponds with different types of food. A sample of 5 fishes was selected from each pond. Their weights are recorded in the table below. Find out if these data suggest a difference in average weight of fishes reared in different ponds (i.e. perform an analysis of variance of the data):

Pond 1	Pond 2	Pond 3
20	28	20
26	26	19
24	30	23
22	31	22
20	27	26

Given that

$F_{2, 12} = 3{\cdot}89$ at 5% level of significance

$F_{2, 12} = 6{\cdot}93$ at 1% level of significance.

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