

PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

BSc DEGREE EXAMINATION DECEMBER 2024
(Fourth Semester)

Branch – MICROBIOLOGY

MATHEMATICS FOR LIFE SCIENCES

Time: Three Hours

Maximum: 50 Marks

SECTION-A (5 Marks)

Answer ALL questions

ALL questions carry EQUAL marks

(5 x 1 = 5)

- 1 The order of the differential equation $y''' + 3(y'')^2 + y' = 0$ is _____.
(i) 1 (ii) 3 (iii) 2 (iv) 4
- 2 The condition for differential equation $M(x,y)dx + N(x,y)dy = 0$ to be an exact equation is _____.
(i) $\frac{\partial M}{\partial y} = 2 \frac{\partial N}{\partial x}$ (ii) $\frac{\partial M}{\partial x} = \frac{\partial N}{\partial y}$
(iii) $\frac{\partial M}{\partial y} + \frac{\partial N}{\partial x} = 0$ (iv) $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$
- 3 The error in the trapezoidal rule is of the order
(i) h^3 (ii) h^4 (iii) h^2 (iv) h^0
- 4 In third order Runge-Kutta method $\Delta y =$ _____.
(i) $\frac{1}{6}(k_1 + 2k_2 + 2k_3)$ (ii) $\frac{1}{6}(k_1 + k_2 + k_3)$
(iii) $\frac{1}{6}(k_1 + 4k_2 + k_3)$ (iv) $\frac{1}{6}(k_1 + k_2 + 2k_3)$
- 5 _____ of an enzymatic reaction can be defined as the rate of the reaction at which the enzyme shows the highest turnover.
(i) accelerator (ii) maximum velocity
(iii) variable parameter (iv) minimum velocity

SECTION - B (15 Marks)

Answer ALL Questions

ALL Questions Carry EQUAL Marks

(5 x 3 = 15)

- 6 a Verify whether $e^y dx + (xe^y + 2y) dy = 0$ is exact, if so solve.
OR
b Solve $y' - y \cot x = 2x \sin x$.
- 7 a If the population of a country doubles in 50 years in how many years will it treble under the assumption that the rate of increase is proportional to the number of inhabitants?
OR
b Solve the equation of the simple harmonic motion.
- 8 a Find the first two derivatives of $(x)^{1/3}$ at $x=50$ and $x=56$.
x : 50 51 52 53 54 55 56
 $y=(x)^{1/3}$: 3.6840 3.7084 3.7325 3.7563 3.7798 3.8030 3.8259

OR

Cont....

- b Evaluate $\int_0^1 \frac{dx}{1+x^2}$ by using Trapezoidal rule with $h=0.2$. Hence obtain an approximate value of π .
- 9 a Using Euler's method, solve numerically the equation, $y' = -y$, $y(0)=1$, for $x = (0.01)(0.01)(0.04)$.
OR
- b Obtain the values of y at $x=0.1, 0.2$ using Runge Kutta method of second order for the differential equation $y' = -y$, given $y(0)=1$.
- 10 a What fraction of $V_{\max}$ observed at $[S]=4K_m, [S]=5K_m, [S]=6K_m, [S]=9K_m$, and $[S]=10K_m$? Calculate the ratios of $[S]_{0.9}/[S]_{0.5}$ and $[S]_{0.75}/[S]_{0.5}$.
OR
- B Explain the Woolf-Augustinsson-Hofstee plot.

SECTION -C (30 Marks)

Answer ALL questions

ALL questions carry EQUAL Marks

(5 x 6 = 30)

- 11 a Solve $\frac{dy}{dx} = \left(\frac{y^3 + 3x^2y}{x^3 + 2xy^2} \right)$.
OR
- b Solve $(1+y^2)dx + (x - \tan^{-1} y)dy = 0$.
- 12 a Explain the Brachistochrone problem.
OR
- b A special rain drop starting from rest falls under the influence of gravity. If it gathers in water vapour (assumed at rest) at a rate proportional to its surface and if its initial radius is 0. Show that it falls with constant acceleration $g/4$.
- 13 a Find the first and second derivative of the function tabulated below at $x=0.6$:
- | | | | | | |
|----|--------|--------|--------|--------|--------|
| x: | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| y: | 1.5836 | 1.7974 | 2.0442 | 2.3275 | 2.6511 |
- OR
- b Evaluate $\int_0^{\pi} \sin x dx$ by dividing the range into ten equal parts, using (i) Trapezoidal rule (ii) Simpson's rule.
- 14 a Using Modified Euler method, find $y(0.25)$, given $\frac{dy}{dx} = 2xy$, $y(0)=1$.
OR
- b Using Runge-Kutta method of fourth order, find $y(0.3)$ correct to 4 decimal places if $\frac{dy}{dx} + y + xy^2 = 0$, $y(0)=1$ by taking $h=0.1$.
- 15 a The equilibrium constant for the reaction $S \leftrightarrow P$ is 5. Suppose we have a mixture of $[S]=2 \times 10^{-4}$ M and $[P]=3 \times 10^{-4}$ M. $K_{mp} = 3 \times 10^{-5}$ M, $V_{\max s} = 2 \mu \text{ moles} \times \text{litre}^{-1} \times \text{min}^{-1}$, $V_{\max r} = 4 \mu \text{ moles} \times \text{litre}^{-1} \times \text{min}^{-1}$.
- (a) In which direction will the reaction proceed on addition of an appropriate enzyme?
(b) At what initial velocity will the reaction start towards equilibrium?
OR
- b An enzyme was assayed at an initial substrate concentration of 2×10^{-5} M. In 6 min, half of the substrate has been used. The K_m for the substrate is 5×10^{-3} M. Calculate (a) K_m (b) $V_{\max}$ (c) the concentration of product by 15 min.