Total No. of Questions : 6]

SEAT No. :

PF-12257

[Total No. of Pages : 4

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BSC-151-BES : ENGINEERING MATHEMATICS - II

(2024 Pattern) (Semester - I/II)

Time : 2½ Hours] *[Max. Marks : 60*

Instructions to the candidates:

1) *All questions are compulsory.*
2) *Neat diagrams must be drawn wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of electronic pocket calculator is allowed.*
5) *Assume suitable data, if necessary.*

Q1) Write the correct option for the following :

a) $\int_0^{\frac{\pi}{2}} \cos^6\theta \, d\theta =$ **[2]**

i) $\frac{5}{16}$ ii) $\frac{5\pi}{32}$

iii) $\frac{16\pi}{10}$ iv) $\frac{5\pi}{96}$

b) The curve r = a + b cos θ cuts θ = 0 line at the point **[2]**

i) (a + b, 0) ii) (a – b, 0)

iii) (a, b) iv) (a, 0)

c) $\int_{\theta=0}^{\frac{\pi}{2}} \int_{r=0}^{2} r \, dr \, d\theta =$ **[2]**

i) 1 ii) 2

iii) $\frac{\pi}{2}$ iv) π

d) Integrating factor of homogeneous differential equation. **[2]**
$(y^2 - 2xy)\,dx + (2x^2 + 3xy)\,dy = 0$ is

i) $\frac{1}{x^2y^2}$ ii) $\frac{1}{x^2y}$

iii) $\frac{1}{4xy^2}$ iv) $\frac{1}{y^2}$

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e) If a particle of mass m is projected vertically upward under gravity, the resistance due to air being mk times the velocity then equation of motion is **[2]**

i) $ma = mg - mkv$ ii) $ma = mg + mkv$

iii) $ma = -mg - mkv$ iv) $ma = -mg + mkv$

Q2) **Solve any Two of the following :** **[10]**

a) If $I_n = \int_0^{\pi/4} \sec^n \theta \, d\theta$, then prove that $I_n = \frac{(\sqrt{2})^{n-2}}{n-1} + \frac{n-2}{n-1} I_{n-2}$. **[5]**

b) Evaluate $\int_0^{\infty} x^9 . e^{-2x^2} dx$. **[5]**

c) Show that $\int_0^{\infty} \frac{x^{12}(1-x^{10})}{(1+x)^{36}} dx = 0$. **[5]**

d) If $I(a) = \int_0^{\infty} \frac{e^{-ax} \sin x}{x} dx$, then prove that $\frac{dI}{da} = \frac{-1}{1+a^2}$. **[5]**

Q3) **Attempt any two :**

a) Trace the curve $x(x^2 + y^2) = a(x^2 - y^2)$ $(a > 0)$. **[5]**

b) Trace the curve $r^2 = a^2 \cos 2\theta$. **[5]**

c) Prove that the sphere **[5]**

$x^2 + y^2 + z^2 + 2x - 4y - 2z - 3 = 0$ touches the plane $2x - 2y - z + 16 = 0$ and find point of contact.

d) Find the equation of the right circular cone whose vertex is at the origin, whose axis is the line $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ and which has a semi-vertical angle 30°. **[5]**

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Q4) **Solve any two of the following :** **[10]**

a) Prove that $\int_0^1 \int_{-\sqrt{y}}^{-y^2} xy \; dx \; dy = \frac{-1}{12}$. **[5]**

b) Evaluate $\iint_R xy(x+y) \; dx \; dy$ where R is the region bounded by $y = x^2$ and $y = x$. **[5]**

c) Change order of following integral with necessary justification **[5]**

$$\int_1^2 \int_y^{y^2} f(x,y) dx \; dy$$

d) Prove that $\int_0^2 \int_0^x \int_0^{\sqrt{x+y}} z \; dz \; dy \; dx = 2$. **[5]**

Q5) **Solve the following (Any two) :** **[10]**

a) $\left(\frac{2x}{y^3}\right) dx + \left(\frac{y^2 - 3x^2}{y^4}\right) dy = 0$ **[5]**

b) $(2x \; log \; x - xy) \; dy + 2y \; dx = 0$ **[5]**

c) $(1+y^2) + \left(x - e^{-\tan^{-1} y}\right) \frac{dy}{dx} = 0$ **[5]**

d) $\text{Cos}\, y - x \sin y \frac{dy}{dx} = \sec^2 x$ **[5]**

Q6) **Solve any two :**

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a) A body originally at 85°C cools to 65°C in 25 minutes, the temperature of air being 40° C, what will be the temperature of the body after 40 minutes? **[5]**

b) A resistance of 100 ohms, an inductance of 0.5 H are connected in series with battery of 20 Volts. Find current in the circuit as a function of 't'.**[5]**

c) A body of mass 'm' falling from rest is subject to the force of gravity and an air resistance proportional to the square of velocity (kv^2). If it falls through distance 'x' and possesses a velocity 'v' at that instant, prove that $\frac{2kx}{m} = \log\left(\frac{a^2}{a^2 - v^2}\right)$, where $mg = ka^2$. **[5]**

d) A pipe 20 cm in diameter contains steam at 150°C and is protected with covering 5cm thick for which k = 0.0025. If the temperature of the outer surface of the covering is 40°C. Find the temperature half way through the covering under steady state condition. **[5]**

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