(Annual-2016) 8 Time Allowed: Maximum Marks: 100

3 Hours

oject: A Course of Mathematics

Attempt Six questions in all by selecting Three questions from each section.

(a) Define continuous function in term of $(\delta - \varepsilon)$ form and discuss the continuity of f(x) = x - [x], $x \in R$, for integral

Define least upper bound and prove that the set $S=\{x:x^2<2\}$ has least upper bound $=\sqrt{2}$.

2(a) If u is a derivable function of v and v is a derivable function of x, then prove that $\frac{du}{dx} = \frac{du}{dv} \cdot \frac{dv}{dx}$.

(2.3(a) If f is differentiable on [a, b] and f' decreases strictly on [a, b], prove that $f'(b) < \frac{f(b) - f(a)}{b - a} < f'(a)$. How is

his result modified if f'increases strictly on [a,b]? Hence show that if $f(x) = \sin x$, $a = \frac{\pi}{3}$, $b = \frac{61\pi}{180}$ then

(b) Evaluate the following limit: $\lim_{x\to 1} ir \frac{(1-x^{m+1})(1-x^{m+2})(1-x^{m+3})...(1-x^{m+k})}{(1-x)(1-x^2)(1-x^3)...(1-x^k)}$. sin 61" - sin 60" < 0.0088.

Q.4(a) Describe the geometrical significance of the derivative of the radius vector with respect to the polar angle.

(b) Show that Pedal equation of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is $\frac{1}{a^2} = \frac{1}{a^2} + \frac{1}{b^2} - \frac{r^2}{a^2b^2}$. 8

Q.5(a) Show that the maximum value of $(\frac{1}{e})^t$ is $(e)^{1/e}$.

(b) If $y(x) = \{x + \sqrt{1 + x^2}\}^m$, prove that $(1 + x^2)y''(x) + xy'(x) - m^2y(x) = 0$ and $(1-x^2)y^{(n-2)}(x)+(2n+1)xy^{(n-1)}(x)+(n^2-m^2)y^{(n)}(x)=0$.

Q.6(a) Find the centre of curvature of the astroid $x^{2/3} + y^{2/3} = a^{2/3}$.

(b) The normal to a given curve is a tangent to its evolute.

Q.7(a) State and prove the fundamental theorem of the integral calculus.

(b) Prove that $\int_{-1}^{\infty} \frac{\ell n(1+x^2)}{1+x^2} dx = \pi \ell n^2$.

Q8(a) Define improper integral and determine the convergence or divergence of the following improper integral and evaluate. The convergent integral $\int e^{-x} x^5 dx$.

(b) Evaluate $\int \frac{x^2}{(1+x^2)^3} dx$. 8/2

Q.9(a) Evaluate $\int_{1+\cos x}^{x+\sin x} dx$. 4/1

(b) (i) If f(x) and g(x) are two antiderivatives of $\phi(x)$ then f(x) and g(x) must differ by a constant. 4/4 (ii) Evaluate $\int_{-x}^{\sqrt{9x^2-1}} dx$.

Q.10(a) Show that the intrinsic equation of the semicubical parabola $ay^2 = x^3$, taking the cusp as the fixed point is

(b) Find the area of the region included between the cardiod $r=2a(1+\cos\theta)$ and the circle $r=6a\cos\theta$.

Q.11(a) Assuming that the area of an ellipse with semi axes a and b is πab , compute the volume of the ellipsoid 8 $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$.

(b) Find the Fourier series representing the function $f(x) = |x|, -\pi \le x \le \pi$.

8 8 Q.12(a) Determine whether the series $\sum_{n=1}^{\infty} \frac{\arctan n}{1+n^2}$ converges or diverges.

(b) Apply any appropriate test to determine the convergence or divergence of the series $\sum_{n=1}^{\infty} \frac{(2n+1)!}{n^2(n+1)!}$ 8 (I-A16-1000)

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Patrick Vollmar

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