

Subject: A Course of Mathematics  
Paper: A  
Attempt Six questions in all by selecting Three questions from each section.

SECTION-I

(a) Define continuous function in term of  $(\delta - \varepsilon)$  form and discuss the continuity of  $f(x) = x - [x]$ ,  $x \in \mathbb{R}$ , for integral values of  $\mathbb{R}$ . 3+6/3

Define least upper bound and prove that the set  $S = \{x : x^2 < 2\}$  has least upper bound  $= \sqrt{2}$ . 2+6/1

2(a) If  $u$  is a derivable function of  $v$  and  $v$  is a derivable function of  $x$ , then prove that  $\frac{du}{dx} = \frac{du}{dv} \cdot \frac{dv}{dx}$ . 9

3(a) If  $y(x) = e^{ax} x^2$ , find a formula for  $y^{(n)}(x)$ . 8/8

Q.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 this 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  $\sin 61^\circ - \sin 60^\circ < 0.0088$ . 9

(b) Evaluate the following limit:  $\lim_{x \rightarrow 1} \frac{(1-x^{n+1})(1-x^{n+2})(1-x^{n+3}) \dots (1-x^{n+k})}{(1-x)(1-x^2)(1-x^3) \dots (1-x^k)}$ . 8

Q.4(a) Describe the geometrical significance of the derivative of the radius vector with respect to the polar angle. 9

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

Q.5(a) Show that the maximum value of  $(\frac{1}{x})^x$  is  $(e)^{1/e}$ . 8

(b) If  $y(x) = (x + \sqrt{1+x^2})^m$ , prove that  $(1+x^2)y''(x) + xy'(x) - m^2 y(x) = 0$  and  $(1-x^2)y^{(n+2)}(x) + (2n+1)xy^{(n+1)}(x) + (n^2 - m^2)y^{(n)}(x) = 0$ . 9/10

Q.6(a) Find the centre of curvature of the astroid  $x^{2/3} + y^{2/3} = a^{2/3}$ . 9

(b) The normal to a given curve is a tangent to its evolute. 8

SECTION-II

Q.7(a) State and prove the fundamental theorem of the integral calculus. 9

(b) Prove that  $\int_0^{\pi} \frac{\ln(1+x^2)}{1+x^2} dx = \pi \ln 2$ . 8

Q.8(a) Define improper integral and determine the convergence or divergence of the following improper integral and evaluate. The convergent integral  $\int_0^{\infty} e^{-x} x^5 dx$ . 2+7/9

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

Q.9(a) Evaluate  $\int \frac{x + \sin x}{1 + \cos x} dx$ . 8/2

(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. 4/1

(ii) Evaluate  $\int \frac{\sqrt{9x^2-1}}{x} dx$ . 4/4

Q.10(a) Show that the intrinsic equation of the semicubical parabola  $ay^2 = x^3$ , taking the cusp as the fixed point is  $27S = 8a(\sec^2 \psi - 1)$ . 8

(b) Find the area of the region included between the cardioid  $r = 2a(1 + \cos \theta)$  and the circle  $r = 6a \cos \theta$ . 8

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

(b) Find the Fourier series representing the function  $f(x) = |x|$ ,  $-\pi \leq x \leq \pi$ . 8

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

(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

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observable practices of the classroom and the meanings attributed to those practices by classroom participants The LPS research design documents sequences of at least ten lessons using three video cameras supplemented by the reconstructive accounts of classroom participants obtained in post lesson video stimulated interviews and by test and questionnaire data and copies of student written material In each participating country data generation focuses on the classrooms of three teachers identified by the local mathematics education community as competent and situated in demographically different school communities within the one major city The large body of complex data supports both the characterisation of practice in the classrooms of competent teachers and the development of theory

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various compressor types vary in capacity to specify particular application of compressor equipment amount of inlet air consumed upon a particular given time prior to compression is also considered a unit capacity

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