3. (a) State and prove Cauchy's mean value theorem
(b) Find 'c' of the mean value theorem

$$f'(c) = \frac{f(b) - f(a)}{b - a} \text{ if } f(x) = x(x-1)(x-2), a = 0, b = \frac{1}{2}$$

4. (a) If $u = \tan^{-1}\frac{x^3 + y^3}{x - y}$ then prove that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \sin 2u$.

(b) Show that the repeated limits exist at (0, 0) and are equal but the double limit does not exist of the function $f(x, y) = \frac{x^2 y^2}{x^2 y^2 + (x - y)^2}$.

5. (a) Discuss the lagrange's method of undetermined multipliers.
(b) In a plane triangle ABC, find maximum value of cos A cos B cos

GROUP - B

6. (a) Prove that a monotonic decreasing sequence bounded below tends to a limit which is its greatest lower bound.

(b) Prove that the sequence $\{a_n\}$ where $a_n = \left(1 + \frac{1}{n}\right)^n$ is convergent and its limit lying between 2 and 3.

7. (a) State and prove Cauchy's condensation test.

(b) Is the sereies $\frac{1^2}{2^2} + \frac{1^2 . 3^2}{2^2 . 4^2} + \frac{1^2 . 3^2 . 5^2}{2^2 . 4^2 . 6^2} + \cdots$ convergent or divergent ?

8. (a) State and prove Leibnitz theorem on alternating series.

(b) Test for absolute convergence of the series $1 - \frac{1}{\lfloor 3} + \frac{1}{\lfloor 5} + \frac{1}{\lfloor 7} + \ldots$

9. (a) Show that $B(\ell, m) = \frac{\Gamma(\ell)\Gamma(m)}{\Gamma(\ell + m)}$.

(b) Evaluate $\int_0^1 \int_0^1 \int_0^1 e^{x+y+z}\, dx\, dy\, dz$

GROUP - C

10. (a) Show that a system of coplaner forces acting in one plane at different points of a rigid body can be reduced to single force through any given point and a single couple.

(b) Three forces P, Q, R act along the sides of a triangle formed by the lines $x + y = 1$, $y - x = 1$, $y = 2$. Find the magnitude and equation of line of action of resultant.

11. (a) Explain the forces which may be omitted in forming the equation of virtual work of a system of coplaner forces acting at different points of a rigid body.

(b) Two equal uniform rods AB and AC, each of length 2b are freely jointed at A and rest on a smooth vertical circle of radius a. If 2θ be the angle between them, prove that $b \sin^3\theta = a \cos\theta$.

12. (a) Find Cartesian equation of a common Catenary.

(b) If tension at point A of Catenary is n times at the vertex, then the span of Catenary ACB is $\frac{2\ell}{\sqrt{n^2-1}} \log\left(n+\sqrt{n^2-1}\right)$, when 2ℓ is the length of the Catenary.

13. (a) Find the equation of the central axis of a system of forces acting on a rigid body.

(b) Find the condition that the straight line $\frac{x-f}{\ell} = \frac{y-g}{m} = \frac{z-h}{n}$ may be a null line for a given system of forces.