University of Sargodha

M.A/M.Sc. Part-I/Composite Exam 2nd A- 2019 & 1st A-2020

Mathematics: I **Real Analysis**

Maximum Marks: 100 **Time Allowed: 3 Hours**

Note: Objective part is compulsory. Attempt any four questions from subjective part.

Objective Part (Compulsory)

Q.1. Write short answers of the following in 2-3 lines each. (2*10)

i. Define supremum and infimum of a subset of real numbers.
ii. Define a bounded sequence of real numbers.
iii. Find $\lim_{x\to 0} x^x$.
iv. Define a decreasing sequence of real numbers?
v. Define the sequence of partial some of an infinite series.
vi. State the p-series test for convergence of an infinite series.
vii. If $z = f(x, y)$ the write the definitions of $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$.
viii. Write the two properties of function of bounded variation.
ix. Discuss the convergence of an improper integral of 1st kind.
x. Define the uniform convergence of sequence of functions.

Subjective Part (4*20)

Q.2. (a) Define a convergent sequence and prove that every convergent sequence of real numbers is bounded but converse may not hold.
(b) State and prove the Cauchy's criterion for convergence of an infinite series.

Q.3. (a) Prove that every differentiable function is continuous, but converse is not valid.
(b) State and prove the "Lagrange's Mean Value Theorem".

Q.4. (a) Let $z = f(x, y)$, $x = g(t)$ and $y = h(t)$ be defined in a domain D, then prove that

$$\frac{dz}{dt} = \frac{\partial z}{\partial x}\frac{dx}{dt} + \frac{\partial z}{\partial y}\frac{dy}{dt}.$$

(b) Find the point of the curve $x^2 - xy + y^2 - z^2 = 1$, $x^2 + y^2 = 1$ which is nearest to the origin.

Q.5. State and prove the two fundamental theorems of integral calculus.

Q.6. (a) Define the improper integrals of both kinds with all types and give example of each kind and each type.
(b) Define the function of bounded variation and show by a counter example that a continuous function may not be a function of bounded variation.

Q.7. (a) Let $\{f_n\}$ be a sequence of continuous functions defined on a set $A \subseteq R$ and suppose that $\{f_n\}$ converges uniformly on A to a function $f : A \to R$. Then prove that f is continuous on A.

(b) Assume that $f \in R(\alpha; a, b,)$ for every $a < b$. Then prove that the integral $\int_a^b f d\alpha$ converges if, and only if, for every $\in > 0$ there exists a $B > 0$ such that $c > b > B$ implies

$$\left|\int_b^c f(x)d\alpha(x)\right| < \in.$$

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