KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks Scored:

Level : B.Sc.
Year : III

Course : MATH 325
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date :

SECTION "A"

[10Q. × 1=10 marks]

Fill in the blank space(s) by most appropriate word(s) or symbol(s):

1. The supremum of the set $S = \{x \in \mathbb{R} \mid o < x < 1\}$ is _____ .
2. A point in two-dimensional space is an _____ of real numbers.
3. The intersection of a finite collection of open sets is _____.
4. A set S in $\mathbb{R}^n$ is said to be compact if, and only if, every open covering of S contains a _____ .
5. If $M = \mathbb{R}^n$; $d(x,y) = \|x - y\|$. This metric is called the _____.
6. In any metric space (S, d) every compact subset T is _____.
7. In Euclidean space $\mathbb{R}^1$, a sequence $\{x_n\}$ is called increasing if _____ for all n.
8. In Euclidean space $\mathbb{R}^k$ every Cauchy sequence is _____.
9. A partition P' of $[a, b]$ is said to be finer than P (or a refinement of P) if _____.
10. Function f is of bounded variation on $[a, b]$ if and only if f can be expressed as difference of two _____.

SECTION "B"

[10 Q. × 1 = 10 marks]

Fill in the blank space(s), **DO NOT TICK**, by selecting the most appropriate answers from among the given ones.

11. The triangle inequality property of metric d is _____.
[$d(x,y) = d(y,z)$; $d(x,y) = d(x,z) + d(y,z)$;
$d(x,y) \geq d(x,z) + d(z,y)$; $d(x,y) \leq d(x,z) + d(z,y)$]

12. If (M, d) is a metric space and $a \in M$, the ball $B(a, r)$ with center a and radius $r > 0$ is defined to be the set of all x in M such that _____ .
[$d(x, a) > r$; $d(x, a) \leq r$; $d(x, a) < r$; $d(x, a) \geq r$]

13. A convergent sequence has only _____ limit(s).
[one; two; three; less than three]

14. A function $f : S \to \mathbb{R}^k$ is called bounded on S if there is a positive number M such that $\|f(x)\|$ _____ M for all x in S.
[$<$; $>$; $\leq$; $\geq$]

15. A metric space (S, d) is called complete if every Cauchy sequence in S _____ in S.
[converges; diverges; continuous; discontinuous]

16. Assume f and g are defined on (a, b) and differentiable at c. Then $(f\,g)'(c) =$ _____.
[$f(c)g'(c) + f'(c)g(c)$; $f(c)g'(c) + f'(c)g(c)$;
$f(c)g(c) + f'(c)g(c)$; $f(c)g(c) + f(c)g'(c)$]

17. If the function $f : \mathbb{R} \to \mathbb{R}$ be defined by $f(x) = x + 7$, then $f^{-1}(-5) =$ _____.
[12; -12; 7; -7]

18. If f is differentiable on $[a, b]$ then it is monotonically increasing if _____.
[$f'(x) = 0$; $f(x)\,f'(x) = 0$; $f'(x) \geq 0$; $f'(x) \leq 0$]

19. If f is of bounded variation on $[a, b]$ then on $[a, b]$ f is _____.
[unbound; bounded; continuous; zero]

20. The function f defined by the equation $f(x) = \lim_{n\to\infty} f_n(x)$, for all x,is called the _____ of the sequence $\{f_n\}$.
[function; limit function; bounded function; unbounded function]

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SECTION "C"
[3Q. × 7 = 21 marks]

1. Define adherent point. Prove that [1+3+3]
   i. the union of any collection of open sets is an open set
   ii. the union of finite collection of closed sets is a closed set.

2. Define bounded and compact set. Let $f : S \to T$ be a function from one metric space (S, d_S) to another (T, d_T). Then prove that f is continuous on S if and only if for every open set Y in T, the inverse image $f^{-1}(Y)$ is open in S. [2 + 5]

OR

Define derivative and one side derivative. Let f be defined on an open interval S, g be defined on $f(S)$ and consider the composite function gof defined on S by the equation $(gof)(x) = g[f(x)]$. Assume there is a point c in S such that $f(c)$ is an interior point of $f(S)$. If f is differentiable at c and if g is differentiable at $f(c)$ then gof is differentiable at c, then prove that $(gof)'(c) = g'[f(c)]f'(c)$. [3 + 4]

3. Define the bounded variation and total variation. Let f be of bounded variation on $[a, b]$. Let V be defined on $[a, b]$ as follows: $V(x) = V_f(a, x)$ *if* $a < x \leq b, V(a) = 0$. Then prove that V is an increasing function on $[a, b]$. [2+ 5]

SECTION "D"
[6 Q. × 4 = 24 marks]

4. State and prove triangle inequality in Euclidean space $\mathbb{R}^n$.

5. Define complete metric space. In any metric space (S, d), prove that every compact subset T is complete.

OR

Define metric space. If $M = \mathbb{R}^n$ and $d = \|x - y\|$, then prove that (M, d) is a metric space.

6. Define continuous function and uniformly continuous function in metric space. Let $f(x) = \frac{1}{x}$ for $x > 0$ and take $A = (0, 1]$. Prove that the function $f(x)$ is continuous on A but not uniformly continuous on A.

7. Define partial derivative. If f is differentiable at c, then prove that f is continuous at c.

8. Define the convergent sequence. Show that a sequence $\{x_n\}$ in a metric space (S, d) can converge to at most one point in S.

9. If $f \in R(\alpha)$ and $g \in R(\alpha)$ on $[a, b]$, then prove that $c_1 f + c_2 g \in R(\alpha)$ on $[a, b]$ (for any two constants c_1 and c_2) and $\int_a^b (c_1 f + c_2 g)\, d\alpha = c_1 \int_a^b f\, d\alpha + c_2 \int_a^b g\, d\alpha$.

SECTION "E"

[5 Q. × 2 = 10 marks]

10. If x is an accumulation point of S, then prove that every n-ball $B(x)$ contains infinitely many points of S.

11. Let $f : S \to T$ be a function from S to T. If $X \subset S$ and $Y \subset T$, then $Y = f(X)$ implies $X \subset f^{-1}(Y)$.

12. If f and g are defined on (a, b) and differentiable at c. Then prove that $(f + g)'(c) = f'(c) + g'(c)$.

13. If f is increasing function on $[a, b]$, then f is of bounded variation on $[a, b]$.

14. Write a sequence of continuous functions with a discontinuous limit function.

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F. M. : 10
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SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate answer from each set of choices.

1. Which of the following according to KVL must be zero?
   a. Algebraic sum of currents in closed-loop
   b. Algebraic sum of power in closed-loop
   c. Algebraic sum of losses in closed-loop
   d. Algebraic sum of voltages in closed-loop

2. Find the current in the circuit (Figure 1).
   a. 1 A b. 2 A c. 3 A d. 4 A

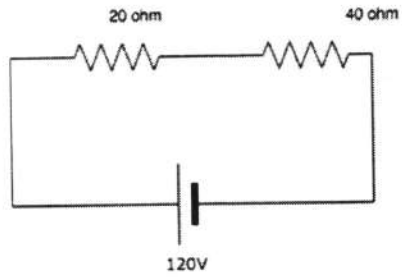

Figure 1

3. A 250 V lamp draws a current of 0.3 A. Calculate the power in the lamp.
   a. 75 W b. 90 W c. 150 W d. 45 W

4. Candela is the unit of _____.
   a. Luminous Flux
   b. Luminous Intensity
   c. Wavelength
   d. Solid angle

5. The illumination is directly proportional to the cosine of the angle made by the normal to the illuminated surface with the direction of the incident flux. The above statement is associated with
   a. Plank's Law
   b. Macbeth's Law of illumination
   c. Bunsen's Law of illumination
   d. Lambert's cosine law

6. One lumen per square meter is the same as
   a. One lux b. One footcandle c. One candela d. One lumen metre

7. Light is produced in electric discharge lamps by
   a. Heating effect of current
   b. Magnetic effect of current
   c. Ionization of gas or vapor
   d. Carbon electrodes

8. Melting temperature of tungsten is
   a. 2000 °C b. 4000°C c. 1500°C d. 3400°C

9. The primary winding of a transformer has a 120V ac supply. What is the value of secondary voltage if the turn ratio is 10?
   a. 120 V b. 12 V c. 1200 V d. 12000 V

10. _____ are the conductors, which connect consumer's terminal to the distribution.
a. Distributors b. Service mains c. Feeders d. Substation

11. A _____ distribution system is more reliable than the _____ distribution system.
a. Parallel, radial b. Radial, parallel c. Parallel, ring d. Ring, parallel

12. The primary function of a fuse is to
a. Open the circuit
b. Protect the appliance
c. Protect the line
d. Prevent excessive current flowing through the circuit

13. MCCB stands for
a. Miniature Circuit Closure Breaker b. Molded Case Circuit Breaker
c. Miniature Case Circuit Breaker d. Molded Circuit Close Breaker

14. Two-way switching means having two or more switches in different locations to control _____ lamp.
a. One b. Two c. Three d. Four

15. The capacity of micro-hydro power plant ranges in between _____.
a. 5 kW to 100 kW b. 1 MW to 10 MW
c. 100 kW to 1 MW d. 10 MW to 100 MW

16. PSTN stand for _____.
a. Public system telephone network b. Private switched telephone network
c. Public switched television network d. Public switched telephone network

17. Sensors converts signals from one energy domain to _____ domain.
a. Electrical b. Mechanical c. Physical d. Digital

18. In the _____transmission mode, communication is unidirectional.
a. Simplex b. Full-duplex c. Half-duplex d. Hybrid

19. Earth electrode for building shall have ohmic resistance less than _____.
a. 5 ohm b. 10 ohm c. 2 ohm d. 20 ohm

20. The minimum cross-sectional area of the protective conductor shall be _____ in case of copper.
a. 1.5 mm dia (6 SWG) b. 2.24 mm dia (13 SWG)
c. 2 mm dia (14 SWG) d. 2.5 mm dia (12 SWG)