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PGIS-N-235 A-21

M.A./M.Sc. I Semester (CBCS) Degree Examination

MATHEMATICS

Operations Research

Paper : SCT - 1.1

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

i. Answer any **Five** questions.
ii. All questions carry **equal** marks.

1. a) Explain briefly the general methods for solving O.R. models. **(8)**

b) A company has three operational departments (weaving, processing and packing) with capacity to produce three different types of clothes namely suitings, shirting and woolens, yielding a profit of Rs. 2, Rs. 4 and Rs. 3 per meter respectively. one meter suiting requires 3 minutes in weaving, 2 minutes in processing and 1 minute in packing. One meter shirting requires 4 minutes in weaving, 1 minute in Processing and 3 minutes in packing, while one meter woolen requires 3 minutes in each department. In a week, total run time of each department is 60, 40 and 80 hours of weaving, processing and packing departments respectively. Formulate the problem as a linear programming problem. **(8)**

2. a) Solve the following L.P.P. by graphical method **(8)**

Maximize $Z = 2x_1 + 3x_2$

Subject to $x_1 + x_2 \leq 30$

$x_2 \geq 3$

$0 \leq x_2 \leq 12$

$0 \leq x_1 \leq 20$

and $x_1, x_2 \geq 0$

b) Solve the following L.P.P. by simplex method **(8)**

Maximize $Z = 4x_1 + 10x_2$

Subject to $2x_1 + x_2 \leq 50$

$2x_1 + 5x_2 \leq 100$

$2x_1 + 3x_2 \leq 90$

and $x_1, x_2 \geq 0$

3. a) Use Big - M method to solve the following L.P.P. **(8)**

Minimize $Z = 5x_1 + 3x_2$

Subject to $2x_1 + 4x_2 \leq 12$

$2x_1 + 2x_2 = 10$

$5x_1 + 2x_2 \geq 10$

and $x_1, x_2 \geq 0$

b) Use two - phase simplex method to solve the following L.P.P. **(8)**

Minimize $Z = x_1 + x_2$

Subject to $2x_1 + x_2 \geq 4$

$x_1 + 7x_2 \geq 7$

and $x_1, x_2 \geq 0$

4. a) Write the dual of the following L.P.P. **(6)**

Maximize $Z = 5x_1 + 3x_2$

Subject to $3x_1 + 5x_2 \leq 15$

$5x_1 + 2x_2 \leq 10$

and $x_1, x_2 \geq 0$

b) Use dual simplex method to solve the following L.P.P. **(10)**

Maximize $Z = 3x_1 + 2x_2$

Subject to $x_1 + x_2 \geq 1$

$x_1 + x_2 \leq 7$

$x_1 + 2x_2 \geq 10$

$x_2 \leq 3$

and $x_1, x_2 \geq 0$

5. a) Explain the method of column minima and row minima to obtain initial basic feasible solution to the given transportation problem. **(10)**

b) Determine the initial basic feasible solution to the following transportation problem by using North - west corner rule **(6)**

(Destinations)

(Origins)		D_1	D_2	D_3	D_4	(Availability)
	O_1	6	4	1	5	14
	O_2	8	9	2	7	16
	O_3	4	3	6	2	5
		6	10	15	4	

(Requirements)

6. a) Write the transportation technique. **(4)**

b) Find the optimum transportation schedule for the following problem by using transportation **(12)**

(Destinations)

(Source)		D_1	D_2	D_3	D_4	(Supply)
	O_1	19	30	50	10	7
	O_2	70	30	40	60	8
	O_3	40	8	40	20	18
		5	8	7	14	

(Demand)

7. a) Solve the following assignment problem **(8)**

	A	B	C	D
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

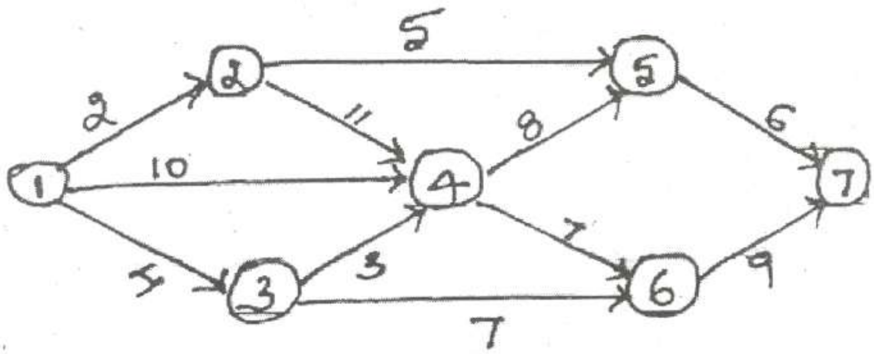
b) Given the following matrix of set up costs, show how to sequence production so as to minimize set up cost per cycle. **(8)**

	A	B	C	D	E
A	∞	2	5	7	1
B	6	∞	3	8	2
C	8	7	∞	4	7
D	12	4	6	∞	5
E	1	3	2	8	∞

8. a) Solve the following game graphically (8)

$$\begin{bmatrix} 1 & -3 \\ 3 & 5 \\ -1 & 6 \\ 4 & 1 \\ 2 & 2 \\ -5 & 0 \end{bmatrix}$$

b) For the following network, find the shortest route from node 1 to node 7. (8)



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PGIS-O-235 A-21
M.Sc. I Semester (CBCS) Degree Examination
MATHEMATICS
Classical Mechanics
Paper : SCT - 1.1
(Old)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

Answer any **Five** full questions.
All questions carry **equal** marks.

1. a) State and prove D'Alembert's principle. **(8)**

   b) Derive Lagrange's equation for impulsive motion. **(8)**

2. a) Obtain Euler's dynamical equations of motion of a rigid body about a fixed point on the body. **(8)**

   b) Prove that $M_z = \frac{\partial L}{\partial \dot{\phi}_i}$ for a system with $L = \frac{1}{2}\sum_i mi\left(\dot{r}_i^2 + r_i^2\varphi_i^2 + \dot{z}_i^2\right) - V(r)$. **(8)**

3. a) Obtain Hamilton's equation of motion of a particle in a plane referred to moving axes, where the components of velocities are $u = \dot{x} - \omega y, v = \dot{y} + \omega x$. **(8)**

   b) Deduce Lagranges and Hamilton equations from Hamilton's principle. **(8)**

4. a) Derive Hamilton's canonical equation from Hamilton's principle. **(8)**

   b) Deduce Poincare integral invariant. **(8)**

5. a) Show that the transformation given by $q = \sqrt{2P}\sin Q, p = \sqrt{2P}\cos Q$ is canonical by using Poisson's bracket. **(8)**

   b) Deduce Whittaker's equations. **(8)**

6. a) Prove that Poisson's bracket are also invariant under canonical transformation. **(8)**

   b) Show that Poisson's bracket of two constants of motion is itself a constant of motion. **(8)**

7. a) A particle of mass m falling under gravity, solve for the motion of the particle using canonical transformation theory. **(8)**

b) Derive Hamilton - Jacobi equation. **(8)**

8. a) Show that the Lagrange's bracket do not obey the commutative law. Also prove the fundamental Lagrange's bracket. **(8)**

b) Find the relationship between Lagrange's and Poisson's bracket. **(8)**

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PGIS-N-230 A-21

M.A./M.Sc. I Semester (CBCS) Degree Examination

MATHEMATICS

Real Analysis

Paper : HCT - 1.1

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates: Answer any **Five** full questions.
All Questions carry **equal** marks.

1. a) If P* is a refinement of P, then show that $L(P^*, f, \alpha) \geq L(P, f, \alpha)$ and $U(P^*, f, \alpha) \leq U(P, f, \alpha)$. **(8)**

   b) If $f \in \mathbb{R}(\alpha_1)$ and $f \in \mathbb{R}(\alpha_2)$. Then prove that $f \in \mathbb{R}(\alpha_1 + \alpha_2)$ and $\int_a^b fd(\alpha_1 + \alpha_2) = \int_a^b fd\alpha_1 + \int_a^b fd\alpha_2$. **(8)**

2. a) Suppose $f \in \mathbb{R}(\alpha)$ on [a,b], $m \leq f \leq M$, ϕ is continuous on [m,M] and $h(x) = \phi[f(x)]$. on [a,b]. Then show that $h \in \mathbb{R}(\alpha)$ on [a,b]. **(8)**

   b) If f and ϕ are continuous on [a,b], ϕ is strictly increasing on [a,b] and χ is inverse function of ϕ. Then prove that $\int_a^b f(x)dx = \int_{\phi(a)}^{\phi(b)} f(\chi(y))d\chi(y)$. **(8)**

3. a) If $f \in \mathbb{R}$ on [a,b] and α is monotone increasing on [a,b] such that $\alpha' \in \mathbb{R}$ on [a,b], then show that $f \in \mathbb{R}(\alpha)$ and $\int_a^b fd\alpha = \int_a^b f\alpha' dx$. **(8)**

   b) If a sequence $\{f_n\}$ converges uniformly in [a,b] and x_0 is a point of [a,b]. Such that $\lim_{n\to\infty} f_n(x) = a_n$, n = 1, 2, ...then prove that

      i. $< a_n >$ converges

      ii. $\lim_{x \to x_0} f(x) = \lim_{n\to\infty} a_n$. **(8)**

4. a) Let a series $\sum f_n$ of differentiable functions converges point wise to f on [a,b] and each f_n' is continuous on [a,b] and the series $\sum f_n'$ converges uniformly to G on [a,b] then prove that the given series $\sum f_n$ converges uniformly to f on [a,b] and $f'(x) = G(x)$. **(8)**

b) If k is compact if $f_n \in G(k)$ for n = 1,2,........ and if $\{f_n\}$ is point wise bounded and equicontinuous on k. then show that

i. $\{f_n\}$ is uniformly bounded on k

ii. $\{f_n\}$ contains a uniformly convergent subsequence. **(8)**

5. State and prove Stone - Weierstrass theorem. **(16)**

6. a) If a power series $\sum a_n x^n$ converges at the end point x = R of the interval of convergence (-R,R), then prove that it is uniformly convergent in the closed interval [0,R]. **(8)**

b) If a function ϕ is bounded and integrable on the interval [a,b], then show that as $n \to \infty$

$A_n = \int_a^b \phi \cos nx dx \to 0$ and

$B_n = \int_a^b \phi \sin nx dx \to 0$ **(8)**

7. a) If f is bounded and integrable on $[-\pi, \pi]$ and if a_n, b_n are its Fourier coefficients, then prove that $\sum_{n=1}^{\infty}\left(a_n^2 + b_n^2\right)$ converges. **(8)**

b) Define gamma function. Find $\Gamma(1/2) = \sqrt{\pi}$. **(8)**

8. a) Prove that a linear operator T on a finite dimensional vector space X is one - to - one if and only if the range of T is all of X. **(8)**

b) If f is differentiable at x_0, then show that f is continuous at x_0. **(8)**

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PGIS-236 A-21

M.Sc. I Semester (CBCS) Degree Examination

MATHEMATICS

Fuzzy Sets and Fuzzy Systems

Paper : SCT - 1.2

(Old)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

1. Answer any **Five** full questions.
2. All Questions carry **Equal** marks.

1. a) State and prove De-Morgan's laws for crisp sets. **(6)**

b) Explain the notion of fuzzy set with suitable example. **(5)**

c) Define α - cut of a fuzzy set and explain with an example. **(5)**

2. a) Define a convexity of fuzzy set and prove that a fuzzy set A on R is convex if and only if $\mu_A(\lambda x_1 + (1-\lambda)x_2) \geq \min\left(\mu_A(x_1), \mu_A(x_2)\right)$ for all $x_1, x_2 \in R$ and $\lambda \in [0,1]$. **(8)**

b) Define standard fuzzy set operations and explain with examples. **(8)**

3. a) If A, B are fuzzy sets defined on the universal set X, then prove that the following holds for all $a, b \in [0,1]$.

i. ${}^{\alpha}(A \cap B) = {}^{\alpha}A \cap {}^{\alpha}B$

ii. ${}^{\alpha}(A \cup B) = {}^{\alpha}A \cup {}^{\alpha}B$ **(8)**

b) If $A, B \in F[X]$, then show the properties hold for all $\alpha \in [0,1]$

i. $A \subseteq B$ iff ${}^{\alpha}A \subseteq {}^{\alpha}B$

ii. $A \subseteq B$ iff ${}^{\alpha+}A \subseteq {}^{\alpha+}B$ **(8)**

4. a) State and prove second decomposition theorem. **(8)**

b) If a function $C:[0,1]\rightarrow[0,1]$ satisfy the axioms C_2 and C_4 of fuzzy complements then prove that it also satisfies axioms C_1 and C_3. **(8)**

5. a) If C is a continuous fuzzy complement then show that C has a unique equilibrium. **(8)**

b) Write the axiomatic skeleton for t - norms. Prove that for all $a,b\in[0,1]$ $i_{min}(a,b)\leq i(a,b)\leq \min(a,b)$ where i_{min} denotes the drastic intersection. **(8)**

6. a) If i_w denote the class of Yager t - norms defined by $i_w(a,b)=1-\min[1,(1-a)^w+(1-b)^w]^{1/w}$ $w>0$ then show that $i_{min}(a,b)\leq i_w(a,b)\leq \min(a,b)$ for all $a,b\in[0,1]$. **(8)**

b) Write axiomatic definition of t-conorms and write any one parameterize class of increasing generator and the corresponding class of t - conorms. **(8)**

7. a) If (i,u,c) is a dual triple that satisifies the law of excluded middle and law of contradiction, then prove that <i,u,c> does not satisfy the distributive law. **(8)**

b) Define a fuzzy number and write an example and also discuss special cases of fuzzy numbers. **(8)**

8. a) Define Linguistic variables and explain with suitable example. **(8)**

b) Write a detailed note on fuzzy equations. **(8)**

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PGIS-N-231 A-21
M.Sc. I Semester (CBCS) Degree Examination
MATHEMATICS
Algebra - I
Paper : HCT - 1.2
(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:
1. Answer any **Five** questions.
2. All Questions carry **Equal** marks.

1. a) Let N be a normal subgroup of a group G and H a subgroup of G. Then prove that NH is a subgroup of G. **(8)**

b) Prove that every quotient group of a cyclic group is cyclic but not conversely. **(8)**

2. a) If $G = H_1 \otimes H_2$ i.e., G is the internal direct product of its subgroups H_1 and H_2, then prove that

i. H_1 and H_2 are normal subgroups of G.

ii. $G/H_1 = H_2$, $G/H_2 = H_1$. **(8)**

b) Suppose H and K are subgroups of a finite group G. Also let $O(H) > \sqrt{O(G)}$, $O(K) > \sqrt{O(G)}$ then show that $H \cap K = \{e\}$. **(8)**

3. a) If a G is an abelian group of order O(G), and if P is a prime number such that $P^{\alpha} / O(G)$, $P^{\alpha+1} + O(G)$, then prove that G has a subgroup of order P. **(8)**

b) State and prove third sylow theorem. **(8)**

4. a) Prove that a group G is solvable iff $G^{(n)} = e$ for some $n \geq 1$. **(8)**

b) State and prove Scheiers theorem. **(8)**

5. a) Define ring, Euclidean domain, Let R be is Euclidean domain. Then show that $a \in R$ is a unit iff d(a) = d(1). **(8)**

b) State and prove unique factorisation domain. **(8)**

6. a) If P is a prime number of the form 4n+1, then we can solve the congruence $x^2 \equiv -1 \bmod p$. **(8)**

b) State and prove FERMAT theorem. **(8)**

7. a) If F is a field, then show that F[x] is a Euclidean domain. **(8)**

b) Let R be a ufd. Then the product of two primitive polynomials over R is also a primitive polynomial. **(8)**

8. a) State and prove Gauss theorem. **(12)**

b) Define R - module submodule and isomorphism of R - module. **(4)**

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PGIS-N-232 A-21

M.Sc. I Semester (CBCS) Degree Examination

MATHEMATICS

Ordinary Differential Equations

Paper : HCT - 1.3

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

1. Answer any **Five** questions.
2. All questions carry **equal** marks.

1. a) State and prove the existence theorem for the solution of second order initial value problem. **(8)**

b) If ϕ_1, ϕ_2 are two solutions of $y'' + a_1(x)y' + a_2(x)y = 0$ in an interval I containing a point x_0 then prove that $W(\phi_1, \phi_2)(x) = e^{-a_1(x-x_0)} . W(\phi_1, \phi_2)(x_0)$. **(8)**

2. a) Let ϕ_1, ϕ_2 be any two linearly independent solutions of L(y) = 0 on an interval I, then show that every solution ϕ of L(y) = 0 can be written uniquely as $\phi = C_1\phi_1 + C_2\phi_2$, where C_1, C_2 are constants. **(8)**

b) Prove that two solutions ϕ_1, ϕ_2 of L(y) = 0 are linearly independent on an interval I if and only if $W(\phi_1, \phi_2)(x) \neq 0$ for all x in I. **(8)**

3. a) Define adjoint and self adjoint equation. Further, transform

$\left(t^4 + t^2\right)\dfrac{d^2x}{dt^2} + 2t^3\dfrac{dx}{dt} + 3x = 0$ into equivalent self adjoint equation. **(8)**

b) Every solution ψ of $L(y) = y'' + a_1y' + a_2y = b(x)$ on I can be written as $\psi = \psi_p + C_1\phi_1 + C_2\phi_2$ where ψ_p is a particular solution, ϕ_1, ϕ_2 are two solutions of L(y) =0 and C_1, C_2 are constants. **(8)**

4. a) State and prove sturm's separation theorem. (8)

b) Show that the boundary value problem $\frac{d^2y}{dx^2}+\lambda y=0$ where y(0)=0, $y(\pi)=0$ is a sturm Liourille problem. (8)

5. a) Find the ordinary and singular point of the differential equation $(x-1)y''+xy'+\frac{1}{x}y=0$. (5)

b) Show that $x = 0$ and $x = -1$ are singular points of the differential equation

$$x^2(x+1)^2y''+(x^2-1)y'+2y=0$$ (5)

c) Define the following.

i. Analytic function

ii. Ordinary point of $y''+P(x)y'+Q(x)y=0$.

iii. Singular point of $y''+P(x)y'+Q(x)y=0$ (6)

6. a) Explain power series solution about an ordinary point. (8)

b) Use the power series method to find the general solution of $(1-x^2)y''+2y=0$, with $y(0)=4,\ y'(0)=5$. (8)

7. a) Explain Gram - Schmidt process of orthonormalization. (8)

b) Define characteristic values and characteristic functions. Further, find characteristic values and characteristic functions of

$$\frac{d}{dx}\left[x.\frac{dy}{dx}\right]+\frac{\lambda}{x}y=0 \text{ with } y'(1)=0, y'(e^{2\pi})=0, \lambda\geq 0.$$ (8)

8. a) Prove that Eigen functions corresponding to different eigen - values are orthogonal with respect to some weight function. (10)

b) Define the following.

i. Orthogonal set of functions.

ii. Orthonormal set of functions. (6)

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PGIS-N-233 A-21

M.Sc. I Semester (CBCS) Degree Examination

MATHEMATICS

Discrete Mathematics

Paper : HCT - 1.4

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

1. Answer any **Five** questions.
2. All questions carry **equal** marks.

1. a) What are logical connectives? Discuss the construction of compound statements with suitable examples **(5)**

b) Prove that, there is no rational number p/q whose square is 2. **(5)**

c) Show by mathematical induction that any finite nonempty set is countable. **(6)**

2. a) Determine the number of ways to paint 12 offices so that 3 of them will be green, 2 of them pink, 2 of them yellow and the remaining once white. **(5)**

b) State and prove the principle of inclusion and exclusion for two sets. **(6)**

c) Find the probability of occurance of an odd number in an experiment of rolling a die. **(5)**

3. a) Define a numeric function and discuss the manipulation of numeric function with suitable examples. **(5)**

b) Solve the recurrence relation $a_r + 6a_{r-1} + 12a_{r-2} + 8a_{r-3} = 0$. **(5)**

c) Solve the recurrence relation $a_r - 4a_{r-1} + 4a_{r-2} = 0$ with $a_0 = 1$ and $a_1 = 6$. **(6)**

4. a) Solve the recurrence relation $a_r - 7a_{r-1} + 10a_{r-2} = 3^r$ with $a_0 = 0$ and $a_1 = 1$. **(8)**

b) Solve the recurrence relation $a_r = 3a_{r-1} + 2, r \geq 1$ with the boundary condition $a_0 = 1$ by the method of generating function. **(8)**

5. a) Define a binary relation and discuss its properties with suitable example. **(8)**

b) If L be a lattice, then prove the following :

i. $a \vee (a \wedge b) = a$

ii. $a \wedge (a \vee b) = a$ **(8)**

6. a) Let L be bounded distributive lattice prove that, if a complement exists, it is unique. **(5)**

b) If $(L, \leq)$ is a Boolean algebra, then for all $a, b \in L$, prove that $(a')' = a$. **(5)**

c) Let $(A, \vee, \wedge, -)$ be a finite Boolean algebra. Let b be any non zero element in A, and $a_1, a_2, ...a_k$ be all the atoms of A such that $a_i \leq b$. Then prove that $b = a_1 \vee a_2 \vee .... \vee a_k$. **(6)**

7. a) Define the following and write an example of each

i. monoid

ii. group

iii. abelian group

iv. order of group. **(8)**

b) State and prove Lagrange's theorem. **(8)**

8. a) Write a detailed note on error detection and error correction in the transmission of binary information. **(6)**

b) Prove that an encoding function $e : B^m \to B^n$ can detect K or fewer errors if and only if its minimum distance is at least (k+1). **(5)**

c) Show that, the encoding function $e : B^3 \to B^6$ defined below is group code. **(5)**

e(000) = 000000

e(001) = 001100

e(010) = 010011

e(011) = 011111

e(100) = 100101

e(101) = 101001

e(110) = 110110

e(111) = 111010

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PGIS-N-234 A-21

M.Sc. I Semester (CBCS) Degree Examination

MATHEMATICS

General Topology

Paper : HCT - 1.5

(New)

Time : 3 Hours **Maximum Marks : 80**

Instructions to Candidates:

1. Answer any **Five** full questions.
2. All questions carry **equal** marks.

1. a) Define closure of a set. Let A and B be subsets of a space X then prove The followings:

i. $\overline{A}$ is the smallest closed set containing A.

ii. A is closed iff $A = \overline{A}$

iii. If $A \subset B$ then $\overline{A} \subset \overline{B}$

iv. $\overline{A \cup B} = \overline{A} \cup \overline{B}$ **(8)**

v. $\overline{(\overline{A})} = \overline{A}$

b) Define Interior of a set. Show that $X - \overline{A} = (X - A)^{o}$. **(8)**

2. a) Define Limit point of a set. If A & B are subsets of a space X, then prove the followings:

i. If $A \subset B$ then $D(A) \subset D(B)$

ii. $D(A \cup B) = D(A) \cup D(B)$. **(8)**

b) Define a base. Let β be a collection of subsets of a non - empty set X. then prove that there exists a topology on X for which β is a base iff

i. $X = U\{B : B \in \beta\}$

ii. If $U, V \in \beta$ and $P \in U \cap V$ then there is $W \in \beta$ such that $P \in W \subset U \cap V$. **(8)**

3. a) Define a continuous mapping. Let X be any space Let T_1 *and* T_2 be two topologies on X then prove that the bijective map $i:(X,T_1)\to(X,T_2)$ is continuous iff $T_2\subset T_1$. **(8)**

b) If $f:X\to Y$ be a Continuous function and $A\subset X$ then show that $f/A:A\to Y$ is continuous. Is the converse true? Justify. **(8)**

4. a) Define a T_2 - space. If a topological space X is T_2 and $f:X\to Y$ is a closed bijection then show that Y is also a T_2 - space. **(8)**

b) Prove the following properties of a regular space are equivalent :

i. X is regular

ii. For each $P\in X$ and an open set U containing P, there is an open Set V such that $P\in\overline{V}\subset U$.

iii. For each $P\in X$ and a closed set F not containing P, there is an open set V such that $P\in V$ and $\overline{V}\cap F=\phi$. **(8)**

5. a) Prove that X×Y is regular iff X & Y are both regular spaces. **(8)**

b) Define a normal space. Show that normality is a topological property. **(8)**

6. a) Define subsequence of a Sequence. Let $f:N\to X$ converges to 'a' in X then prove that every subsequence of f in X converges to 'a'. **(8)**

b) Prove that any continuous image of a connected space is Connected. **(8)**

7. a) Prove that every closed and bounded interval on $\mathbb{R}$ is compact where $\mathbb{R}$ has usual topology μ. **(8)**

b) Prove that the space X is compact iff every collection of closed sets with FIP has a non empty intersection. **(8)**

8. a) Define a Metric space. Prove that every separable metric space (X,d) is 2° - countable. **(8)**

b) Define a Lindelof space. Prove that a metric space is Lindelof iff it is second countable. **(8)**
