Reg. No:

G.T.N. ARTS COLLEGE (AUTONOMOUS)

(Affiliated to Madurai Kamaraj University) || (Accredited by NAAC with 'B' Grade)

END SEMESTER EXAMINATION – NOVEMBER 2020

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., Mathematics	**Date: 14.02.2022**
Course Code: 20PMAC11	**Time: 10am – 1pm**
Course Title: Algebra – I	**Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	The order of the symmetric group S_3 is __________. [a] 3 [b] 6 [c] 12 [d] 4	CO1	K1
2.	In a group $(G,*), a$ is an element of order 12. Then the order of a^5 is ________. [a] 12 [b] 15 [c] 17 [d] 19	CO1	K2
3.	Let G be a group of order p^q where p and q are prime numbers such that $p > q$. Then G can have _____________. [a] almost one subgroup of order p [b] atleast one subgroup of order q [c] atleast one subgroup of order p [d] atleast one subgroup of order q	CO2	K1
4.	If f is a homomorphism $f: (R, +) \to (Z, \times)$ such that $f(2) = 3$, then $f(6)$ is __________ [a] 6 [b] 9 [c] 18 [d] 27	CO2	K2
5.	The group P_n of all permutations of degree n is called _________. [a] the symmetric group [b] the non-symmetric group [c] transposition [d] abelian group	CO3	K1
6.	What is the order of the normalizer of $\sigma = (1\ 2)(3\ 4)$in S_6? [a] 8 [b] 16 [c] 24 [d] 4	CO3	K2
7.	If $O(G) = 1001$, then about G correct statements is __________. I) only $13 -$ sylow subgroup is normal II) $11 -$ sylow subgroup $13 -$ sylow subgroup are normal III) all sylow subgroup are normal IV) G is non-cyclic [a] I and IV [b] III [c]II and IV [d] all are correct	CO4	K1
8.	If $O(G) = 231$, then the center of G is _________. [a] $11 -$ Sylow sub group [b] $7 -$ Sylow sub group [c] $3 -$ Sylow sub group [d] $\{e\}$	CO4	K2
9.	An integral domain D is of finite characteristic, if $\forall\ a \in D$, there exist m a positive integer such that ___________. [a] $ma = 1$ [b] $ma = 0$ [c] $ma = a$ [d] $ma = a^2$	CO5	K1
10.	If R is a ring in which $a^4 = a$, for all $a \in R$, then ____________. [a] R is commutative [b] R is not commutative [c] $R$is zero ring [d] R is a Boolean ring	CO5	K2

Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Construct a Cayley table for $U(12)$	CO1	K2

	[OR]		
b)	If H and K are subgroups of G then prove that $H \cap G$ is also a subgroup of G.	CO1	K2
12.a)	Define $Aut(G)$ and prove that $Aut(G)$ is a group under function composition.	CO2	K2
	[OR]		
b)	Show that the mapping $\phi(a + bi) = a - bi$ is an automorphism of the group of complex numbers under addition. Show that ϕ preserves complex multiplication as well.	CO2	K2
13.a)	If G is a finite group and $a \in G$ then show that $a^{O(G)} = e$.	CO3	K2
	[OR]		
b)	Let ϕ be a group homomorphism from G to $\overline{G}$. Prove that Ker ϕ is a normal subgroup of G.	CO3	K2
14.a)	If $\lvert G \rvert = p^2$ where p is prime then prove that G is Abelian.	CO4	K3
	[OR]		
b)	Let $\lvert G \rvert = 2p$ where p is an odd prime. Prove that G is isomorphic to Z_{2p}.	CO4	K3
15.a)	Prove that the subset $S = \left\{\begin{pmatrix} a & 0 \\ b & 0 \end{pmatrix} : a, b \in Z\right\}$ of the ring $(M_2(Z), +, .)$ is a left ideal but not a right ideal.	CO5	K3
	[OR]		
b)	State and prove first isomorphism theorem.	CO5	K3

Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer Any THREE Questions**	**CO(s)**	**K – Level**
16.	Prove that (i) center of a group G is a subgroup of G (ii) for any element a in G, the centralizer of a is a subgroup of G.	CO1	K2
17.	Let $G = SL(2, R)$ be the group of 2×2 real matrices with determinant 1 and let M be any 2×2 real matrix with determinant 1; Prove that the mapping $\phi_M : G \to G$ defined by $\phi_M(A) = MAM^{-1}$ for all $A \in G$ isan isomorphism.	CO2	K3
18.	Let ϕ be a homomorphism from a group G to a group $\overline{G}$ and let H be a subgroup of G. Then prove that (i). $\phi(G) = \{\phi(h) \mid h \in H\}$ is a subgroup of $\overline{G}$ (ii). if H is normal in G then $\phi(H)$ is normal in $\phi(G)$ (iii). if $\overline{K}$ is a normal subgroup of $\overline{G}$, then $\phi^{-1}(\overline{K}) = \{k \in G \mid \phi(k) \in \overline{K}\}$ is a normal subgroup of G.	CO3	K3
19.	State and prove Sylow's third theorem.	CO4	K4
20.	Prove that $M_2(Z) = \left\{\begin{pmatrix} a & b \\ c & d \end{pmatrix} : a, b, c, d \in Z\right\}$ is a non-commutative ring under and addition and multiplication of matrices.	CO5	K5

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END SEMESTER EXAMINATION – NOVEMBER 2020

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., Mathematics	**Date: 15.02.2022**
Course Code: 20PMAC12	**Time: 10am – 1pm**
Course Title: Analysis – I	**Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	Extended real number system means______. [a] $R\ \cup\{\infty\}\cup\{-\infty\}$ [b] $R\cup\{\infty\}$ [c] $R\cup\{-\infty\}$ [d] $R\cup\{\}$	CO1	K1
2.	Let $P=\{(x-a)^2+(y-b)^2\ =1;a,b\in Q\}$ where p is the set of all unit circles in the complex plane with centre as rational coordinates which of the following is true? [a] p is finite nonempty set [b] p is countable [c] $p$is uncountable [d] p is empty	CO1	K2
3.	A subset of a complete metric space is complete if and only if it is __________. [a] Closed [b] Open [c] both [a] and [b] [d] neither [a] nor [b]	CO2	K1
4.	If $< M,\rho >$ be a complete metric space and A is a closed subset of M then $< A,\rho >$ is ___________. [a] Bounded [b] complete [c] connected [d] disconnected.	CO2	K2
5.	Let $(x)=\int_1^\infty \frac{cost}{x^2+t^2}\,dt$. Then which of the following are true? [a] f is bounded on R [b] f is continuous on R [c] f is not defined everywhere on R [d] Both [a] and [b].	CO3	K1
6.	The set $\{\frac{x^2}{1+x^2}/x\in R\}$ is ____________. [a] connected but not compact in R [b] compact but not connected in R [c] connected and compact in R [d] neither connected nor compact in R	CO3	K2
7.	The derivative of the function $f(x)=x\lvert x\rvert$ is ___________. [a] $2x$ [b] $2\lvert x\rvert$ [c] $-2x$ [d] doesn't exist	CO4	K1
8.	If $f'(x)=0$ for all $x\in[a,b]$ then f(x) is ________ on [a,b]. [a] derivative [b] primitive [c] constant [d] identity	CO4	K2
9.	Non empty open interval is __________. [a] countable [b] not measure zero [c] measure zero [d] infinite	CO5	K1
10.	If E_1 and E_2 are measurable subsets of [a,b] then E_1-E_2 is___________. [a] countable [b] not measure zero [c] measure zero [d] measurable	CO5	K2
Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Find a rational number between two real numbers. [OR]	CO1	K2

b)	Prove that the Cartesian product of two countable set is countable.	CO1	K2
12.a)	Let E be a subset of the metric space M, then prove that neighborhood of E is open..	CO2	K2
	[OR]		
b)	Show that a set E is open if and only if its complement is closed.	CO2	K2
13.a)	If f is a continuous mappings of a compact metric space X into R^k, then prove that f is closed and bounded.	CO3	K3
	[OR]		
b)	Show that $f(x) = \left\{\begin{matrix} 2 & if\ x \neq 1 \\ 3 & if\ x = 1 \end{matrix}\right\}$ has a removable discontinuous at $x = 1$.	CO3	K3
14.a)	State and prove chain rule theorem.	CO4	K1
	[OR]		
b)	State and prove Taylor’s theorem.	CO4	K1
15.a)	If f is Continuous on $[a, b]$ then prove that $f \in R(\alpha)$ on $[a, b]$.	CO5	K3
	[OR]		
b)	If $f \in R[a, b]$ then prove that $f^2 \in R[a, b]$.	CO5	K3
Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer Any THREE Questions**	**CO(s)**	**K – Level**
16.	. For every real $x > 0$ and every integer $n > 0$.Show that there is one and only one positive real y, such that $y^n = x$ this number is written as $(x)^{1/n}$	CO1	K3
17.	Show that i) for any collection $\{G_\alpha\}$ of open sets $\bigcup_\alpha G_\alpha$ is open . ii) for any collection $\{F_\alpha]$ of closed sets $\bigcap_\alpha F_\alpha$is closed.	CO2	K3
18.	Test whether the continuity of following problem $f(x) = \left\{\begin{matrix} x+2 & if\ x \leq -2 \\ -x-2 & if -2 < x < 0 \\ x+2 & if\ x \geq 0 \end{matrix}\right\}$	CO3	K3
19.	Find the Rolle’sconstant for the function $f(x) = \sqrt{1-x^2}$ in $[-1, 1]$.	CO4	K2
20.	Find upper sum and lower sum of $f(x) = x$ and P is a partition $\{0, \frac{1}{3}, \frac{2}{3}, 1\}$ of $[0, 1]$.	CO5	K4

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END SEMESTER EXAMINATION – NOVEMBER 2020

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., Mathematics	**Date: 16.02.2022**
Course Code: 20PMAC13	**Time: 10am – 1pm**
Course Title: Ordinary Differential Equations	**Max. Marks: 60**

Qn. No.	**Section – A [10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	What is the order and degree of differentialequation $\frac{d^2y}{dx^2} = [\,4 + (\frac{dy}{dx})^2]^{3/4}$? [a] 2,4 [b] 4,2 [c] 2,2 [d]4,3	CO1	K1
2.	What is the Lipschitz constant of the function $f(x, y) = 4x^2 + y^2$ on R for $\lvert x\rvert \le 1, \lvert y\rvert \le 1$? [a] 2 [b] 3 [c] 4 [d] 0	CO1	K2
3.	The solution of the differential equation is of the form $y = px + p^n$ is __________. [a] $y = cx + c^n$ [b] $y = Px$ [c] $y = c^n$ [d] $y = Px + P^n + c$	CO2	K1
4.	Which curve touches each member of one parameter family of curves? [a] trajectories [b]envelope [c]developable [d] edge of regression	CO2	K2
5.	The complementary function of $(D^2 - 8D + 16)y = e^{4x}$ is __________. [a] $\frac{x^2}{2}e^{4x}$ [b] $Ae^{4x} + Be^{-4x}$ [c] $Acos4x + Bsin4x$ [d] $(Ax + B)e^{4x}$	CO3	K1
6.	The particular integral of $x^2y'' - xy' + y = 2logx$ is ____________. [a] $2x + 4$ [b] $2logx + 4$ [c] $2e^x + 4$ [d] $-2logx + 4$	CO3	K2
7.	What is the Wronskian value of e^x and e^{2x} ? [a] e^x [b] e^{2x} [c] e^{3x} [d] e^{4x}	CO4	K1
8.	The given functions f and g are independent in the differential equation, then the wronskian value of the above functions is _________. [a] ≥ 0 [b] ≤ 0 [c] $= 0$ [d] $\neq 0$	CO4	K2
9.	The collection of all eigenvectors of a function is known as _________. [a] eigenspace [b] spectrum [c] eigenfunctions [d] radiusfunction	CO5	K1
10.	The eigen values of the Strum liouville's problem are ___________. [a] zero [b] non negative [c] imaginary [d] real	CO5	K2
Qn. No.	**Section – B [5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Solve the differential equation $\frac{d^2y}{dx^2} = x^2\frac{dy}{dx} + x^4y$ where $y = 5$ and $\frac{dy}{dx} = 1$, when $x = 0$.	CO1	K2
	[OR]		
b)	Explain Picard's iterative method	CO1	K2
12.a)	Find the singular solution of the differential equation $xp^2 - (y - x)p - y = 1$	CO2	K2
	[OR]		
b)	Solve the differential equation $y = px + p - p^2$	CO2	K2
13.a)	Solve the differential equation	CO3	K2

	$x^4(\frac{d^4y}{dx^4}) + 6x^3(\frac{d^3y}{dx^3}) +4x^2\left(\frac{d^2y}{dx^2}\right) - 2x(\frac{dy}{dx}) - 4y = 2\cos(\log x)$		
	[OR]		
b)	Solve the differential equation $(x^4D^3 + 2x^3D^2 - x^2D + x)y = 1.$	CO3	K2
14.a)	Solve the differential equation $y_2 + y = cosec\, x$.	CO4	K3
	[OR]		
b)	Use the variation of parameters method show that solution of equation $\frac{d^2y}{dx^2} + k^2y = \phi(x)$ satisfying the initial condition $y(0) = 0\,;\, y' = 0$ is $y(x) = \frac{1}{k}\int_0^x \phi(t)sink(x-t)dt$	CO4	K3
15.a)	Find the eigen values and eigen function of Strum-liouville problem $X'' + \lambda X = 0 \;\; X(0) = 0, X'(\frac{\pi}{2}) = 0$.	CO5	K3
	[OR]		
b)	Prove that corresponding to each eigenvalue of Strum liouville problem there exist just one linearly independent eigenfunctions.	CO5	K3

Qn. No.	**Section – C [3 x 10 = 30]** **Answer Any THREE Questions**	**CO(s)**	**K – Level**
16.	Find the third approximation of the solution of the equation $\frac{dy}{dx} = z\frac{dy}{dx} = x^3(y + z)$ by Picard's method, $y = 1$ and $z = \frac{1}{2}$ when $x = 0$.	CO1	K2
17.	Find the general and singular solution of equation $\sin px \cos y = \cos px \sin y + p$.	CO2	K3
18.	Solve Legendre's equation $\frac{d^3y}{dx^3} - \left(\frac{4}{3}\right)\left(\frac{d^2y}{dx^2}\right) + \left(\frac{5}{x^2}\right)\left(\frac{dy}{dx}\right) - \left(\frac{2y}{x^3}\right) = 1$.	CO3	K3
19.	Using the method of variation of parameters solve $(\frac{d^2y}{dx^2}) -2(\frac{dy}{dx}) + y = x\, e^x \sin x$ with $y(0) = 0$ and $(\frac{dy}{dx})_{x=0} = 0$.	CO4	K4
20.	Find the eigen values and eigen function of Strum-liouville problem $X'' + \lambda X = 0$, $X'(0) = 0$ and $X'(L) = 0$.	CO5	K5

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END SEMESTER EXAMINATION – NOVEMBER 2020

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., Mathematics	**Date: 17.02.2022**
Course Code: 20PMAC14	**Time: 10am – 1pm**
Course Title: Numerical Analysis	**Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	The formula $x_{k+1} = x_k - \frac{f_k}{f_k'} - \frac{1}{2}\frac{f_k^2}{f_k'^3} f_k''$ is used in _________ method. [a] secant b] Regula-Falsi [c] Chebyshev [d] bisection	CO1	K1
2.	What is the value of Δq, if $P_3(x) = x^3 + x^2 - x + 2 = 0$ with $p_0 = -0.9, q_0 = 0.9$ by using Bairstow method? [a] 0.1047 [b] - 0.1047 [c] 0.1031 [d] - 0.1031	CO1	K2
3.	If $A = -A^T$ then the real matrix A is ______. [a] Symmetric [b] Skew symmetric [c] Orthogonal [d] Triangular	CO2	K1
4.	The matrix $A = \begin{bmatrix} -13 & -4 \\ -4 & 3 \end{bmatrix}$ is _________. [a] positive definite [b] semi positive definite [c] negative definite [d] semi negative definite	CO2	K2
5.	In Lagrange linear interpolating polynomial the value of $l_0(x)$ is _________. [a] $\frac{x+x_1}{x_0+x_1}$ [b] $\frac{x-x_1}{x_0+x_1}$ [c] $\frac{x-x_1}{x_0-x_1}$ [d] $\frac{x_1-x}{x_1-x_0}$	CO3	K1
6.	The value of x if $x_0 = 0.6$, n = 2.6 and h = 0.2. [a] 12 [b] 1.2 [c] 1.12 [d] 1.22	CO3	K2
7.	The approximation may further deteriorate as the order of ________increases. [a]Derivative [b] Divide [c] Converge [d] Diverges	CO4	K1
8.	Trapezoidal rule gives exact value of the integral when the integrand is a ___. [a] linear function [b] quadratic function [c] cubic function [d] polynomial of any degree	CO4	K2
9.	In the second order Runge-kutta method the slope of K_1 is ___________. [a] $hf(t_j, u_j)$ [b] $h + f(t_j, u_j)$ [c] $h - f(t_j, u_j)$ [d] $f(t_j, u_j)$	CO5	K1
10.	What is the percentage relative error if $= 0.67, u^* = 0.66$? [a] 1.5925 [b] 1.4925 [c] 1.3925 [d] 0	CO5	K2
Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Perform two iterations of the Chebyshev method to find an approximate value of $\frac{1}{7}$, with initial approximation as $x_0 = 0.1$.	CO1	K2
	[OR]		
b)	Performone iteration of the Bairstow method to find the smallest positive root of the equation $f(x) = x^3 + x^2 - x + 2 = 0p = -0.9, q = 0.9$.	CO1	K2
12.a)	If A is strictly diagonally dominant matrix, then show that the Jacobi iteration scheme converges for any initial starting vector.	CO2	K2
	[OR]		

b) Perform one iteration to find the solution of the system of equations $\begin{bmatrix} 4 & 1 & 1 \\ 1 & 5 & 2 \\ 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 2 \\ -6 \\ -4 \end{bmatrix}$ by using Jacobi iteration method. CO2 K2

13.a) Obtain the piecewise quadratic interpolation polynomial for the function $f(x)$ defined on the interval $[-3,-1]$ by the data. CO3 K3

x	-3	-2	-1	1	3	6
$f(x)$	369	222	171	165	207	990

Calculate the approximate value of$f(-2.5)$.

[OR]

b) Calculate the value of $f(1.5)$by using quadratic spline interpolation with $M(0) = f''(0) = 0$ for the given data. CO3 K3

x	0	1	2
$f(x)$	1	2	33

14.a) Find the Jacobian matrix for the system of equations $f_1(x,y) = x^2 + xy^2 - y^3 = 0$ and $f_2(x,y) = xy + 5x + 6y = 0$ at the points (1,2)and (0.5,1). CO4 K2

[OR]

b) Find the value of I = $\int_0^1 \frac{dx}{1+x^2}$using the Simpson's rule. CO4 K2

15.a) Using the Euler method to calculate the values of $u(0.2)$ and $u(0.4)$ numerically the initial value problem $u' = -2tu^2, u(0) = 1$ with $h = 0.2$ on the interval [0, 1]. CO5 K3

[OR]

b) Calculate the value of $y(0.1)$ Runge-Kutta method of third order given that $u' = u^2 + ut,$ u(1) $= 1$. CO5 K3

Qn. No. **Section – C** **[3 x 10 = 30]** **CO(s)** **K – Level**

Answer Any THREE Questions

16. Determine all the roots of the polynomial $x^3 - 6x^2 + 11x - 6 = 0$ by using Graeffe's root squaring method. CO1 K3

17. Determine all the eigen values of the matrix A = $\begin{bmatrix} 1 & 2 & -1 \\ 2 & 1 & 2 \\ -1 & 2 & 1 \end{bmatrix}$ using the Jacobi method. Iterate till the third rotation. CO2 K3

18. $S_3(x)$is the piecewise cubic Hermite interpolating approximant of $f(x) = sinxcosx$ in the abscissas 0,1,1,5,2,3. Estimate the error$max_{0 \le x \le 3} |f(x) - S_3(x)|$. CO3 K5

19. Solve the integral I = $\int_{-1}^{1} (1-x^2)^{3/2} \cos x \, dx$, using the Gauss-Chebyshev 1-point , 2-point and 3-point quadrature rules. CO4 K3

20. Solve the initial value problem $u' = -2tu^2, u(0) = 1$ with $h = 0.2$ on the interval [0, 0.4] by using the P – C method $P: u_{j+1} = u_j + \frac{h}{2}(3u'_j - u'_{j-1})$ CO5 K4

C: $u_{j+1} = u_j + \frac{h}{2}(u'_{j+1} + u'_j)$, and also estimate$P(EC)^m$E, m = 2

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END SEMESTER EXAMINATION – NOVEMBER 2020

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., Mathematics **Date: 18.02.2022**
Course Code: 20PMAC15 **Time: 10am – 1pm**
Course Title: Integral Equations **Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	CO(s)	K – Level
1.	The type of integral equation $\phi(x)y(x) = f(x) + \lambda \int_a^b k(x,t)y(t)dt$ where $\phi(x), f(x)$ and $k(x,t)$ are known functions, a and b are known constant and λ is a known parameter, is a ___________. [a] linear integral equation of Volterra type [b] linear integral equation of Fredholm type [c] non-linear integral equation of Volterra type [d] non-linear integral equation of Fredholm type	CO1	K1
2.	The solutions corresponding to eigen values of λ can be expressed as ________. [a] sum of eigenfunctions [b] difference of eigenfunctions [c] arbitrary multiples of eigenfunctions [d] product of eigenfunctions	CO1	K2
3.	The solution of the integral equation$y(x) = sin\, x - \frac{x}{4} + \frac{1}{4}\int_0^{\frac{\pi}{2}} xty(t)dt$ is ___________. [a] $y(x) = cos\, x$ [b] $y(x) = sin\, x$ [c] $y(x) = tan\, x$ [d] $y(x) = 0$	CO2	K1
4.	The initial value problem corresponding to the integral equation$y(x) = 1 + \int_0^x y(t)dt$is ________. [a] $y' - y = 0 , y(0) = 1$ [b] $y' + y = 0, y(0) = 0$ [c] $y' - y = 0, y(0) = 0$ [d] $y' + y = 0, y(0) = 1$	CO2	K2
5.	For the homogeneous Fredholm integral equation$\phi(x) = \lambda \int_0^1 e^{x+t}\, \phi(t)dt$ a non-trivial solution exists, then the value of λ is ________. [a] $\lambda = 2/e - 1$ [b] $\lambda = 1/e^2 + 1$ [c] $\lambda = 1/e + 1$ [d] $\lambda = 2/e^2 - 1$	CO3	K1
6.	If λ_1, λ_2 be the eigen values and f_1 , f_2be the corresponding eigen functions for the homogeneous integral equation $y(x) = \lambda \int_0^1 (2xt + 4x^2)y(t)dt$, then ____________. [a] $\lambda_1 = \lambda_2$ [b] $\lambda_1 \neq \lambda_2$ [c] either a or b. [d] both a and b.	CO3	K2
7.	Let $\emptyset(x)$ be the solution of $\int_0^x e^{x-t}\, \emptyset(t)dt = x, x > 0$ then $\emptyset(1)$ equals ____ [a] -1 [b] 0 [c] 1 [d] 2	CO4	K1
8.	Consider the integral equation $y(x) = x^3 + \int_0^x sin(x - t)y(t)dt , x \epsilon [0, \pi]$then the value of $y(1)$is ________.	CO4	K2

	[a] $\frac{19}{20}$ [b] 1 [c] $\frac{17}{20}$ [d] $\frac{21}{20}$		
9.	The resolvent kernel R(x,t,λ) for the volterra integral equation$\phi(x) = x + \lambda \int_0^x \phi(x)ds$is____________. [a] $e^{\lambda(x+t)}$ [b] $e^{\lambda(x-t)}$ [c] $\lambda\, e^{x+t}$ [d] $e^{\lambda xt}$	CO5	K1
10.	Using the method of successive approximations, the solution of the integral equation $y(x) = 1 + \int_0^x (x-t)y(t)dt\,, y_0(x) = 1$ is ________. [a] $y(x) = sinx$ [b] $y(x) = cosx$ [c] $y(x) = coshx$ $[d]\, y(x) = sinhx$	CO5	K2

Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Findthe solution of the Fredholm integral equation $y(x) + \int_0^1 x(e^{xt} - 1)y(t)dt = e^x - x;\, y(x) = 1.$	CO1	K2
	[OR]		
b)	Explain Volterra integral equation and its kind.	CO1	K2
12.a)	Convert the following differential equation into integral equation $y'' + y = 0$,$y(0) = 0,\, y'(0) = 0.$	CO2	K2
	[OR]		
b)	Convert the integral equation into differential equation $y(x) = \int_0^x (x-t)y(t)dt - x\int_0^1 (1-t)y(t)dt.$	CO2	K2
13.a)	Find the homogeneous Fredholm integral equation of the second kind $y(x) = \lambda \int_0^{2\pi} sin(x+t)\, y(t)dt.$	CO3	K2
	[OR]		
b)	Find the eigenvalues and the corresponding eigenfunctions of the homogeneous integral equation$y(x) = \lambda \int_0^1 (2xt - 4x^2)y(t)dt.$	CO3	K2
14.a)	Solve $y(x) = f(x) + \lambda \int_0^1 xt\, y(t)dt.$	CO4	K3
	[OR]		
b)	Solve the integral equation $y(x) = x + \lambda \int_0^1 (4xt - x^3)\, y(t)dt.$	CO4	K3
15.a)	Determine the resolvent kernel for the Fredholm integral equation $K(x,t) = (1+x)(1-t); a = 0\,, b = 1.$	CO5	K3
	[OR]		
b)	Using iterative method ,solve $y(x) = f(x) + \lambda \int_0^1 e^{x-t}\, y(t)dt.$	CO5	K3

Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer Any THREE Questions**	**CO(s)**	**K – Level**
16.	Examine the function $y(x) = e^x$ is a solution of the integral equation $y(x) + \lambda \int_0^1 \sin xt\; y(t)dt = 1$	CO1	K3
17.	Modify the integral equation into differential equation $y(x) = 1 - x - 4\, sinx + \int_0^x [3 - 2(x-t)y(t)dt.$	CO2	K3
18.	Determine the eigenvalues and eigenfunctions of the homogeneous equation $y(x) = \lambda \int_0^1 k(x,t)y(t)dt$, where $K(x,t) = \begin{cases} x(t-1), 0 \le x \le t \\ t(x-1), t \le x \le 1 \end{cases}$	CO3	K3
19.	Evaluate the Fredholm integral equation of the second kind $$y(x) = x + \lambda \int_0^1 (xt^2 + x^2t)y(t)dt.$$	CO4	K5
20.	Evaluate $y(x) = x + \int_0^x (t-x)y(t)dt.$	CO5	K4

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G.T.N. ARTS COLLEGE(AUTONOMOUS)

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme :M.Sc., MATHEMATICS **Date: 03.02.2022**
Course Code : 20PMAC21 **Time: 2:00 PM – 5:00PM**
Course Title : Algebra - II **Max. Marks 60**

Qn. No.	**Section – A (10 * 1 = 10 Marks)** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	If an ideal U of a ring R contain a unit of R, then _________. [a] $U = R$ [b] $U \neq R$ [c] $U < R$ [d] $U < R$	CO1	K1
2.	Which of the following is not a field? [a] $\frac{Z}{2Z}$ [b] $\frac{Z}{3Z}$ [c] $\frac{Z}{4Z}$ [d] $\frac{Z}{5Z}$	CO1	K2
3.	If $f(x)$ and $g(x)$ are primitive polynomials, then_______ is a primitive polynomials. [a] $f(x)/g(x)$ [b] $f(x) = g(x)$ [c] $f(x) - g(x)$ [d] $f(x)g(x)$	CO2	K1
4.	If $f(x), g(x)$ are in $R[x]$,then $c(fg) =$ _________. [a] $c(g)c(f)$ [b] $c(f)c(g)$ [c] $cf(cg)$ [d] $c(fg)$	CO2	K2
5.	If L is a finite extension of K and if K is a finite extension of F, then _________. [a]L is a Finite extension of F [b] K is a finite extension of F [c]F is a finite extension of K [d] None of these	CO3	K1
6.	If $a \in K$ is algebraic of degree n over F, then _________. [a] $[F(a): F] < n.$ [b] $[F(a): F] > n$ [c] $[F(a): F] = n.$ [d] $[F(a): F] \geq n$	CO3	K2
7.	Let K be a field and let G be a finite subgroup of the multiplicative group of non-zero elements of K. Then G is_________ [a]Cyclic group [b] Field [c] Isomorphic [d] None of these	CO4	K1
8.	If K in algebraic of degree n over F, then $[F(a): F] =$ ________ [a] 1 [b] 0 [c] $2n$ [d] n	CO4	K2
9.	K is a normal extension of F is K is a finite extension of F such that F is the_________ of G (K, F) [a]subfield [b] automorphism [c] fixed field [d] subgroup	CO5	K1
10.	The fixed field of S_n they form a subfield of $F(X_1, \dots \dots X_n)$ called the______	CO5	K2

of symmetric rational function.
[a] group [b] subfield.
[c] field [d] ring

Qn. No.	Section – B (5 * 4 = 20 Marks) Answer ALL the Questions	CO(s)	K – Level
11.a)	Let R be Euclidean ring. Then prove that any two elements a and b in R have greatest common division d. Also prove that $d = \lambda a + \mu b$ for some $\lambda, \mu \in R$.	CO1	K2
	[OR]		
11.b)	If p is a prime number of the form $4n + 1$ then solve the congruence$x^2 \equiv -1\ (mod\ p)$.	CO1	K2
12.a)	State and prove Gauss Lemma.	CO2	K2
	[OR]		
12.b)	If $a \in R$ is an irreducible element and a/bc, then prove that a/b or a/c.	CO2	K2
13.a)	If L is a finite extension of F and K is a subfields of L which contains F , then prove that $[K:F] \| [L:F]$.	CO3	K2
	[OR]		
13.b)	Prove that the sum of two algebraic integers is an algebraic integer.	CO3	K2
14.a)	Prove that for any $f(x), g(x) \in F[x]$ and any $\alpha \in F$, 1. $\big(f(x) + g(x)\big)' = f'(x) + g'(x)$ 2. $(\alpha f(x))' = \alpha f'(x)$ 3. $\big(f(x)g(x)\big)' = f'(x)g(x) + f(x)g'(x)$.	CO4	K3
	[OR]		
14.b)	Show that any field of characteristic zero is perfect.	CO4	K3
15.a)	Prove that $G(K, F)$ is a subgroup of the group of all automorphisms of K.	CO5	K3
	[OR]		
15.b)	If K is finite extension of F, then prove that $G(K:F)$ is a finite group and its order $O\big(G(K:Q)\big)$ satisfies $O\big(G(K:F)\big) \leq [K:F]$.	CO5	K3

Qn. No.	Section – C (3 * 10 = 30 Marks) Answer ANY 3 Questions	CO(s)	K – Level
16.	Prove that if R is a commutative ring with unit element and M is an ideal of R, then M is a maximal ideal of R if and only if R/M is a field.	CO1	K2
17.	State and prove the Eisenstein Criterion.	CO2	K2
18.	Prove that the element $a \in K$ is algebraic over F if and only if $F(a)$ is a finite extension of F.	CO3	K3
19.	Prove that any finite extension of field of characteristic 0 is simple extension.	CO4	K3
20.	State and prove fundamental theorem of Galois theory.	CO5	K4

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS	**Date: 04.02.2022**
Course Code: 20PMAC22	**Time: 2 pm To 5 pm**
Course Title: Analysis - II	**Max. Marks: 60**

Qn. No.	**Section – A [10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	The sequence $a_n = \{1,1,1,\dots\}$ converges to _______. [a] ∞ [b] 1 [c] n [d] 0	CO1	K1
2.	The series $\sum \frac{(-1)^n}{n}$ is conditionally _______. [a] Monotonic [b] Divergent [c] Convergent [d] Both a and b	CO1	K2
3.	If every uniformly converges sequence is also________. [a] Converges [b] Diverges [c] Pointwise converges [d] Bounded	CO2	K1
4.	For every interval $[\,a, a]$ there is a sequence of real polynomials P_n such that $P_n(x)$ = _________. [a] 0 [b] 1 [c] ∞ [d] -1	CO2	K2
5.	Every member of an equicontinuous family is _______________. [a] Continuous [b] Discontinuous [c] equi continuous [d] uniform continuous	CO3	K1
6.	If K is compact if $f_n \in l(k)$ for $n = 1,2,3, \dots \dots ..$ and if $\{f_n\}$ is pointwise bounded and equi continuous on K then $\{f_n\}$ is a ___________ on K. [a] Uniformly bounded [b] Uniformly continuous [c] Equicontinuous [d] Bounded	CO3	K2
7.	A mapping A of a vector space X into a vector space Y is said to be a ____. [a] Spans [b] Linear transformation [c] subspace [d] Invertible	CO4	K1
8.	The uniqueness is a triviality, for if $\varphi(x) = x$ and $\varphi(y) = y$, then_________ .	CO4	K2

[a] $d(x,y) \leq c\, d(x,y)$ [b] $d(x,y) \geq c\, d(x,y)$

[c] $d(x,y) < c\, d(x,Y)$ [d] $d(x,y) > c\, d(x,y)$

9. If $A \in L(R^n)$ then A is invertible if and only if rank of A is ___________. CO5 K1

[a] 1 [b] 2

[c] n [d] n^2

10. If P is a projection in X, then every element x of X has unique solution of the form__________ where $x_1 \in R\,(P),\ x_2 \in N(P)$. CO5 K2

[a] $x = x_1 + x_2$ [b] $x = x_1 - x_2$

[c] $x = x_1 . x_2$ [d] None of these

Qn. No.	Section – B [5 x 4 = 20] Answer ALL the Questions	CO(s)	K – Level
11.a)	If $\{k_n\}$ is a sequence of compact sets in X such that $K_n \supset K_{n+1}$ $(n = 1, 2, \ldots)$and if $\lim_{n\to\infty} diam\ K_n = 0$, then prove that $\bigcap_{n=1}^{\infty} K_n$ consists of exactly one point.	CO1	K2
	[OR]		
b)	Prove that Cauchy sequence in a metric space is bounded .	CO1	K2
12.a)	Show that a convergent series of continuous functions may have a discontinuous sum.	CO2	K2
	[OR]		
b)	Prove that limit sequence of integrable function is need not be integrable.	CO2	K2
13.a)	If K is a compact metric space, if $f_n \in C(K)$ for $n = 1,2,3, \ldots$ and if $\{f_n\}$ converges uniformly on K, then prove that $\{f_n\}$ is equi-continuous on K.	CO3	K2
	[OR]		
b)	Let B be the uniform closure of an algebra$A$ of bounded functions. Then prove that B is uniformly closed algebra.	CO3	K2
14.a)	Let $A \in L(R^n, R^m)$, $B \in L(R^n, R^m)$ and $C \in L(R^m, R^k)$. Then prove that a) For $x \in R^n$, $\lvert Ax \rvert \leq \lvert\lvert A \rvert\rvert \lvert x \rvert$, b) If $\lvert Ax \rvert \leq \lambda \lvert x \rvert$ for all $x \in R^n$, then $\lvert\lvert A \rvert\rvert \leq \lambda$, $\lambda \in R$.	CO4	K3
	[OR]		
b)	Suppose f maps a convex open set $E \subseteq R^n$into R^m, f is differentiable in E and there is a real number M such that $\lvert\lvert f'(x) \rvert\rvert \leq M$ for every $x \in M$. Then prove that $\lvert f(b) - f(a) \rvert \leq M \lvert b - a \rvert$ for all $a \in E$, $b \in E$.	CO4	K3
15.a)	Suppose X and Y are vector spaces and $A \in L(X, Y)$. Prove that $R(A)$ is a vector space in Y.	CO5	K3

[OR]

b)	Suppose f is defined in an open set $E \subset R^2$, suppose that $D_1 f, D_{21} f$ and $D_2 f$ exist at every point of E, and $D_{21} f$ is continuous at some point $(a, b) \in E$.	CO5	K3

Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	Prove that e is irrational.	CO1	K2
17.	Prove that a sequence of functions $\{f_n\}$ converges point wise to f with respect to metric of $C(X)$ if and only if $f_n \to f$ uniformly on X.	CO2	K2
18.	State and Prove Stone Weierstrass Theorem.	CO3	K3
19.	State and prove inverse function theorem.	CO4	K3
20.	a) If P is a projection in X, then prove that every element $x \in X$ has unique representation of the form $x = x_1 + x_2$ where $x_1 \in R(P)$ and $x_2 \in N(P)$. b) If X is a finite dimensional vector space and if X_1 is a vector space in X_1, then prove that there exists a projection P in X with $R(P) = X_1$.	CO5	K4

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS **Date: 05.02.2022**
Course Code: 20PMAC23 **Time: 2 pm. To 5 pm**
Course Title: Partial Differential Equations **Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	Which of the following is an example for first order linear partial differential equation? [a] Lagrange's partial differential equation [b] Clairaut's partial differential equation [c] One-dimensional wave equation [d] One-dimensional Heat equation	CO1	K1
2.	The solution of the Lagrange's partial differential $equation\ xp + yq = z$ is _______. [a] $f(x/y, z/y) = 0$ [b] $f(y/x, y/z) = 0$ [c]$f(x/y, y/z) = 0$ [d] $f(x, y) = 0$	CO1	K2
3.	Which of the following represents the equation $U_{xx} + U_{yy} = U_z$ is [a] Parabolic [b] Hyperbolic [c] Elliptic [d] None of these above	CO2	K1
4.	The first canonical form of the PDE of $W_{\xi\xi} + b(\xi, \eta)W_{\xi\eta} + c(\xi, \eta)W_{\eta\eta} = \phi(\xi, \eta, W, W_\xi, W_\eta)$ given by $W_{\xi\eta} = \psi(\xi, \eta, W, W_\xi, W_\eta)$ is ________. [a] $a = c = 0$ [b] $b = 0, c = -a$ [c] $a = b = 0$ [d] $b = 0, c = a$	CO2	K2
5.	The singular solution of $y = px + a(1 + p^2)^{1/2}$ is _______. [a] Parabola [b]Hyperbola [c] Circle [d] Straight line	CO3	K1

6. Consider the assertion (A) and reason (R) given below: CO3 K2

Assertion(A): $y = 0$is the singular solution of the differential equation $9yp^2 + 4 = 0$ where $p = \frac{dy}{dx}(x-c)^2/_a$

Reason(R): $y = 0$ occurs both in p-discriminant and c-discriminant obtained from its general solution $y^3 + (x+c)^2 = 0$ of $9yp^2 + 4 = 0$

[a] Both A and R are true and R is correct explanation of A

[b] Both A and R are true and R is not correct explanation of A

[c] A is true but R is false

[d] A is false but R is true

7. If $u(x,t)$ satisfy the partial differential equation $(\partial^2 u/\partial t^2) = 4(\partial^2 u/\partial x^2)$, then $u(x,t)$ can be of the form__________. CO4 K1

[a] u(x,t) = f(x– 2t) + g(x+2t)

[b] u(x,t) = f($x^2 - 4t^2$) + g(x^2+4t^2)

[c] u(x,t) = f(2x – 4t) + g(x+2t)

[d] u(x,t) = f(2x – t) + g(2x+t)

8. If $u = u\ (x,t)$ be the solution of the Cauchy problem $\frac{\partial u}{\partial t} + \left(\frac{\partial u}{\partial x}\right)^2 = 1,\ x \in R, t > 0$. Then_______. CO4 K2

[a] $u(x,t)$ exists for all $x \in R$, and t > 0.

[b] $[u(x,t), 0] \to\ \infty$ as $t \to\ \infty$ for some $t > 0\ and\ x \neq 0$

[c] $u(x,t) > 0\ for\ all\ x \in R\ and\ for\ all\ t < \frac{1}{4}$

[d] $u(x,t) > 0\ for\ all\ x \in R\ and\ 0 < t < 1/4$

9. Let $u(x,t) = e^{iwx}\ v(t)$ with $v(0) = 1$ be a solution to $\frac{\partial u}{\partial t} = \frac{\partial^3 u}{\partial x^3}$. Then _________. CO5 K1

[a] $u(x,t) = e^{iw(x-w^2t)}$ [b] $u(x,t) = e^{iwx-w^3t}$

[c] $u(x,t) = e^{iw(x+w^2t)}$ [d] $u(x,t) = e^{iw^3(x-t)}$

10. Which one of the following is true for the wave equation: CO5 K2

$$(\partial^2 u\ /\ \partial x^2) + (\partial^2 u\ /\ \partial y^2) + (\partial^2 u\ /\ \partial z^2) = (1\ /\ c^2) \times (\partial^2 u\ /\ (\partial t^2)?$$

[a] Elliptic [b] Parabolic

[c] Hyperbolic [d] All the above

Qn. No.	Section – B [5 x 4 = 20] Answer ALL the Questions	CO(s)	K – Level
11.a)	Describe the equation $(x^2 + 2y^2)p - xyq = xz$.	CO1	K2

	[OR]		
b)	Describe the equation $p + 3q = 5z + tan(y - 3x)$.	CO1	K2
12.a)	Classify the following partial differential equation $xyr-(x^2-y^2)s-xyt+py-qx=2(x^2-y^2)$	CO2	K2
	[OR]		
b)	Describe $y(x+y)(r-s)-xp-yq-z=0$	CO2	K2
13.a)	Describe the equation $x^2\left(\frac{\partial^2 z}{\partial x^2}\right)-3xy\left(\frac{\partial^2 z}{\partial x\partial y}\right)+2y^2\left(\frac{\partial^2 z}{\partial x^2}\right)+5y\left(\frac{\partial z}{\partial y}\right)-2z = 0$	CO3	K2
	[OR]		
b)	Describe the equation $yt-q=xy$	CO3	K2
14.a)	Solve boundary value problem $\frac{\partial u}{\partial x} = 4\left(\frac{\partial u}{\partial y}\right)$, if $u(0,y) = 8e^{-3y}$.	CO4	K3
	[OR]		
b)	Apply the method of separation of variables, solve: $(\partial u/\partial x) - \mathrm{u} = 2(\partial u/\partial t)$, where $u(x,0) = 6e^{-3x}$.	CO4	K3
15.a)	Explain D'Alembert's solution of one dimensional wave equation.	CO5	K3
	[OR]		
b)	Solve the one dimensional diffusion equation $\frac{\partial^2 u}{\partial x^2} = \left(\frac{1}{k}\right)\left(\frac{\partial u}{\partial t}\right)$ in the range $0\le x\le 2\pi, t\ge 0$ subject to the boundary conditions $u(x,0) = sin3x$ for $0\le x\le 2\pi$ and $u(0,t) = u(0,2\pi) = 0$ for $t\ge 0$.	CO5	K3
Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	Solve, $2xz - px^2 - 2qxy + pq$ and also find the complete and singular integrals.	CO1	K3
17.	Solve the differential equation $(y-1)r-(y^2-1)+y(y-1)t+p-q=2ye^{2x}(1-y)^3$ to canonical form.	CO2	K3
18.	Solve: $(x^2D^2-2xyDD'-3y^2D'^2+xD-3yD')z = x^2ycos(\log x^2)$	CO3	K3
19.	Solve $\partial u/\partial t = (\partial^2 u/\partial x^2), 0 < x < 3, t > 0$, given that $u(0,t) = u(3,t) = 0, u(x,0) = 5\,sin\,4\pi x - 3\,sin\,8\pi x + 2\,sin\,10\pi x, \lvert u(x,t)\rvert < M, M$ being a positive real number.	CO4	K4

20. Determine the D'Alembert's solution of the following Cauchy problem of an infinite string CO5 K5

$u_u - c^2 u_{xx} = 0, x \in R, \quad t > 0, u(x,0) = f(x), x \in R, u_1(x,0)$

$= g(x)\ x \in R.$

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END SEMESTER EXAMINATIONS – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., Mathematics	**Date: 07.02.2022**
Course Code: 20PMAC24	**Time: 2 pm. - 5 pm**
Course Title : Operations Research	**Max. Marks 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	While solving IP problem any non integer variable in the solutions is picked- up to _______. [a] Obtain the cut constraint [b] Enter the solutions [c] Leave the solution [d] None of the above	CO1	K1
2.	If all the variables in the optimum solutions thus obtained have _______. [a] Variable values [b] Non integer values [c] Only integer values [d] None of these	CO1	K2
3.	The important advantage of goal programming is that it can be solved by modified version of _______. [a] simplex method [b] dual simplex method [c] GP model [d] single goal model	CO2	K1
4.	Goal programming can be applied to almost _______ managerial decision areas. [a] unlimited [b] limited [c] equal [d] none of these	CO2	K2

5. If the earliest starting time for an activity is 8 weeks, the latest finish time is 37 weeks and the duration time of the activity is 11 weeks, then the total is equal to _______.

[a] 18 weeks CO3 K1

[b] 14 weeks

[c] 56 weeks

[d] 40 weeks

6. Which one of the following is assumed for timing the activities is PERT network?

[a] α distribution

[b] β distribution CO3 K2

[c] Binomial distribution

[d] Erlangian distribution

7. The individual's satisfaction level over a risky decision and its outcomes is _______.

[a] Events

[b] Payoff table CO4 K1

[c] Utilities

[d] Acts

8. The environment where the availability of information for a decision environment is partial, then it is known as _______.

[a] Decision making under Risk

[b] Decision making under Uncertainty CO4 K2

[c] Decision making under certainty

[d] Decision making under Conflict

9. Which one of the following satisfies the necessary and sufficient condition for an absolute maximum of f(x) at $\bar{x}$ in Kuhn Tucker method is following:

I. $\frac{\partial L(\bar{x}, \bar{\lambda}, \bar{s},)}{\partial x_j} = 0, \ j = 1,2,\ldots.n$

II. $\lambda_i \ (g_i \ (\bar{x}) - \ (b_i) = 0, i = 1,2, \ldots.n$

III. $(g_i \ (\bar{x}) \ \leq \ (b_i), i = 1,2, \ldots.n$

IV. $\lambda_i \ \geq \ 0, i = 1,2, \ldots.n$

[a] 1 & 2 CO5 K1

[b] 2 & 3

[c] 1 & 3

[d] all of above

10. In General Quadratic Programming Problem if $X^T\ Q\ X$ is negative definite then it is _______ in X over all of R^n .

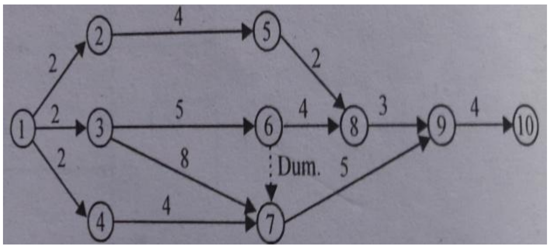
[a] concave

[b] con vex

[c] Strictly concave

[d] strictly convex

CO5 K2

Qn. No.	Section – B [5 x 4 = 20] Answer ALL the Questions	CO(s)	K – Level
11.a)	Define Goal Programming and Distinguish between LP and Goal Programming	CO1	K2
	[OR]		
11.b)	Explain the algorithm involved in the iterative solution to all L.P.P	CO1	K2
12.a)	A company is considering all allocation of Rs. 150,000 advertising budget to two magazines (A and B). Rated exposures per hundred rupees of advertising expenditure are 1,000 and 750, respectively, for the two magazines; and it has been forecast that on the average Rs.10 in sales results from each advertisement exposure. Management has decided that no more than 75% of the advertising budget can be expended in magazine [A] The company has indicated that it would like to achieve exactly 1.5 million exposures from its advertising program. Management’s objective is to allocate its money to advertising in such a way that sales (Rs.) are maximized.	CO2	K2
	[OR]		
12.b)	Give the difference between linear programming and goal programming.	CO2	K2
13.a)	Mention the main features of critical path.	CO3	K3
	[OR]		
13.b)	Consider the following network where nodes have been numbered according to the Fulkerson’s Rule. Numbers along various activities represent the normal time (D_{ij}) required to finish that activity 	CO3	K3
14.a)	Under an employment promotion programming, it is proposed to allow sale of newspapers on the buses during off-peak hours. The vendor can purchase the newspaper at a special concessional rate of 25 paise per copy against the selling price of 40 paise. Unsold copies are, however, a dead loss. A vendor has estimated the	CO4	K3

following probability distribution for the number of copies demanded.

Number of copies demanded	15	16	17	18	19	20
Probability	0.04	0.19	0.33	0.26	0.11	0.07

How many copies should he order so that his expected profit will be maximum?

[OR]

14.b) A manager must choose between two investments A and B which are calculated to yield net profits of Rs. 1,200 and Rs. 1,600 respectively, with probabilities is subjectively estimated at 0.75 and 0.60. Assume the manager's utility function reveals that utilities for Rs. 1,200 and Rs. 1,600 amounts are 40 and 45 units, respectively. What is the best choice on the basis of expected utility value (EUV)? CO4 K3

15.a) Prove that necessary and sufficient conditions for the optimum solution of the following non-linear programming problem: CO5 K2

Minimize $z = f(x_1, x_2) = 3e^{2x_1+1} + 2e^{x_2+5}$, Subject to the constraints:

$x_1 + x_2 = 7$, and $x_1, x_2 \geq 0$

[OR]

15.b) Find the dimensions of a rectangular parallelopiped with largest volume whose sides are parallel to the coordinate plane ,to be inscribed in the ellipsoid CO5 K2

$$G(x\,,y,z) \equiv \left(\frac{x2}{a2}\right) + \left(\frac{y2}{b2}\right) + \left(\frac{z2}{c2}\right) - 1 = 0$$

Qn. No. **Section – C** **[3 x 10 = 30]** **CO(s)** **K – Level**

Answer ANY THREE Questions

16. Use Branch-and-Bound method technique to solve the following integer programming problem Max z $= 7x_1 + 9x_2$, subject to $-x_1 + 3x_2 \leq 6$, $7x_1 + x_2 \leq 35$, $x_1 \geq 0$, $x_2 \leq 7$ and are integers. CO1 K3

17. Use modified simplex method to solve the complete goal programming formulation is again reproduced as : CO2 K3

Minimize z $= p_1 d_1^- + 2p_2 d_2^- + p_2 d_3^- + p_3 d_1^-$,

Subject to : $x_1 + x_2 + d_1^- - d_1^+ = 400$; $x_1 + d_2^- = 240$; $x_2 + d_3^- = 300$,

and $x_1, x_2\,, d_1^-, d_1^+\,, d_2^-, d_3^- \geq 0$

18. Table below shows, jobs, their normal time and cost, and crash time and cost for a project.

JOB	Normal Time (days)	Cost (Rs.)	Cost Time (days)	Crash Cost (days)
1-2	6	1400	4	1900
1-3	8	2000	5	2800
2-3	4	1100	2	1500
2-4	3	800	2	1400
3-4	Dummy	---	---	---
3-5	6	900	3	1600
4-6	10	2500	6	3500
5-6	3	500	2	800

Indirect cost for the project is Rs. 300 per day

(i) Draw the network of the project

(ii) What is the normal duration cost of the project?

(iii) If all activities are crashed, what will be the project duration and corresponding cost?

(iv) Find the optimum duration and minimum project cost.

CO3 K4

19. A farmer is attempting to decide which of three crops he should plant on his one-hundred acre farm. The profit from each crop is strongly dependent on the rainfall during the growing season. He organized the amount of rainfall as substantial, moderate or light. He estimate his profit for each crop as shown the table:

Rainfall	Estimated profit (Rs)		
	Crop A	Crop B	Crop C
Substantial	7000	2500	4000
Moderate	3500	3500	4000
Light	1000	4000	3000

Depending on the weather in previous seasons and the current projection for the coming season, he estimates the probability of substantial rainfall as 0.2 that of moderate rainfall as 0.3 and that of light rainfall 0.5. Furthermore, services of forecasters could be employed to provide a detailed survey of current rainfall prospects as given in the table below:

CO4 K5

Rainfall prediction

Actual rainfall	Substantial	Moderate	Light
Substantial	0.70	0.25	0.05
Moderate	0.30	0.60	0.10
Light	0.10	0.20	0.70

a) From the available data, determine the optimal decision as to which crop to plant.

b) Determine whether it would be economical for hire the services of a forecaster.

20. Apply Beale's method for solving the quadratic programming problem:

Max $z_x = 10\,x_1 + 25x_2 - 10x_1^2 - 4\ x_1\,x_2 - x_2^2,$ subject to CO5 K3

$x_1 + 2x_2 + x_3 = 10,\ x_1 + x_2 + x_4 = 9$, and $x_1, x_2\,, x_3, x_4 \geq 0$. +

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS **Date: 08.02.2022**
Course Code: 20PMAC25 **Time: 2 pm - 5 pm**
Course Title: Calculus of Variations **Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	The extremal of the functional $\int_a^b (12xy + y'^2) dx$ is _______. a) $y(x) = x^3$ b) $y(x) = x^3 - c_1x - c_2$ c) $y(x) = x^3 + c_1x + c_2$ d) $y(x) = 0$	CO1	K1
2.	The extremal of the following functional $\int_a^b y^2\, dx$ is_______. a) $y(x) = 0$ b) $y(x) = 1$ c) $y(x) = 2$ d) $y(x) = 3$	CO1	K2
3.	Which is the extremal of the following functional $I[z(x,y)] = \int_D [(p^2 + q^2) + 2z\, f(x,y)]\, dxdy$? a) Poisson equation b) Euler equation c) Isopermetric d) Cauchy equation	CO2	K1
4.	The value of the extremal for the functional $\int_0^{\frac{\pi}{2}} (2xy + x'^2 + y'^2)\, dx$ with the boundary condition $x(0) = 0, x(\pi/2) = 1$ and $y(0) = 0, y(\pi/2) = 1$ is _______. a) $x = -sint\ , y = sint$ b) $x = cost, y = -cost$ c) $x = sint, y = -sint$ d) $x = siny, y = cost$	CO2	K2

5.	The extremals of the functional $I\,(y) = \int_0^{\frac{\pi}{2}}(y''^2 - y^2 + x^2)dx$ is ________. a) one parameter family of curves b) two parameter family of curves c) three parameter family of curves d) four parameter family of curves.	CO3	K1
6.	The extremal for $J(y) = \int_0^{log3}(e^{-x}y'^2 + 2e^x(y' + y)dx,$ where $y(log3) = 1$ and $y(0)$ is free is ________. a) 4-e^x b) 10-e^x c) 2-e^x d) 8-e^x	CO3	K2
7.	Test for an extremum of the functional $I[y(x)] = \int_0^1 e^2(y^2 + \frac{y'^2}{2})dx$ is ________. a) Strong maxima b) Strong minima c) Weak maxima but not a strong maxima d) Weak minima but not a strong minima	CO4	K1
8.	Examine the function $f(x,y) = 3x^2 + 6xy + 7y^2 - 2x + 4y$ then ________. a) (13/12,-3/4) is a critical point b) Local minimum at (-13/12,-3/4) c) Local maximum at (-13/12,-3/4) d) (12,14) strong maxima	CO4	K2
9.	The boundary value problem $y'' - y + x = 0,\ (0 \le x \ge 1)$ is ________. a) $y(x) = c_0 + c_1x + c_2x^2$ b) $y(x) = c_0 + c_1x^2 + c_2x$ c) $y(x) = c_0 + c_1x + c_2x^3$ d) $y(x) = c_0 + c_1x$	CO5	K1
10.	The boundary value problem$y^n = 1$, $y(0) = 0, y(1) = 0$ by Rayleigh-Ritz method is ________. a) $y(x) = c(x - x^2)$ b) $y(x) = c(x^2 - x)$ c) $y(x) = c(x + x^2)$ d) $y(x) = 0$	CO5	K2

Qn. No.	Section – B [5 x 4 = 20] Answer ALL the Questions	CO(s)	K – Level
11.a)	Explain the extremal of the functional $I(y) = \int_0^e (xy'^2 + yy')\, dx$ subject to the condition $y(1) = 0, y(e) = 1$.	CO1	K2
	[OR]		
b)	Explain the extremal $I[y(x)] = \int_a^b (y''^2 - 2y'^2 + y^2 - 2ysinx)\, dx$.	CO1	K2
12.a)	Show that the extremal of the isopermetric problem $I[y(x)] = \int_1^4 y'^2\, dx$ with $y(1) = 3, y(4) = 24$ to condition $\int_1^4 ydx = 36$ is a parabola.	CO2	K2
	[OR]		
b)	Explain the extremal of the functional $I = \frac{1}{2}\int_0^1 y''^2\ dx$ such that $y(0) = 0, y(1) = ½, y'(0) = 0, y'(1) = 1$.	CO2	K2
13.a)	Solve the shortest distance from the point $A(-1, 3)$ and the straight line $y = 1 - 3x$.	CO3	K3
	[OR]		
b)	Solve the shortest distance between the point $(0, 1)$ and $y = x^2$.	CO3	K3
14.a)	Solve the extremum of the functional $I(y) = \int_0^1 e^x \left(y^2 + \frac{y'^2}{2}\right) dx$.	CO4	K3
	[OR]		
b)	Explain the proper and central field of extremals for the function $I = \int_0^{\frac{\pi}{4}} (y'^2 - y^2 + 2x^2 + 4)\ dx$.	CO4	K3

15.a)	Explain the least eigen value of $y'' + \lambda y = 0 , y'(0) = 0 , y(1) = 0$.	CO5	K2
	[OR]		
b)	Identity the Poisson equation $u_{xx} + u_{yy} = -1$ on a square defined by $\lvert x \rvert \leq 1 , \lvert y \rvert \leq 1$ and $u = 0$ when $x = \pm 1 , y = \pm 1$.	CO5	K2
Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	Construct the path on which a particle in the absence of friction will slide from one point to another in the shortest time under the action of gravity.	CO1	K3
17.	Solve the extremal of the functional $I[y(x)] = \int_0^{\frac{\pi}{2}}[\, y''^2 - y^2 + x^2]dx$ with the condition $y(0) = 1, y'(0) = 0 \;\; and \;\; y\left(\frac{\pi}{2}\right) = 0, y'\left(\frac{\pi}{2}\right) = -1$.	CO2	K3
18.	Summarize the minimum distance between circle $x^2 + y^2 = 1$ and straight line $x + y = 4$.	CO3	K5
19.	Test for an extremum the functional $I[y(x)] = \int_0^1 (x + 2y + \frac{y'^2}{2})\, dx,$ with the condition $y(0) = y(1) = 0$.	CO4	K4
20.	Show that the extremal of the variational problem $\int_0^2 (y'^3 + \sin^2 x)\, dx$ with the condition $y(0) = 0 ,\; y(2) = 6$ is included in a central field of extremals of the given functional.	CO5	K3

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END SEMESTER EXAMINATION – NOVEMBER 2020

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc. Mathematics **Date: 03.02.2022**
Course Code: 20PMAC31 **Time: 10 am. to 1 pm.**
Course Title : Linear Algebra - I **Max. Marks: 60**

Section – A [20 x 1 = 20]

Answer ALL the Questions **CO(s)** **K – Level**

1. Which of the following is a subspace of R^3? CO1 K1

[a] all vectors of the form $(\mathbf{0},\boldsymbol{a},\mathbf{0})$ where $\boldsymbol{a} \in \boldsymbol{R}$

[b] all vectors of the form $(a,1,1)$ where $a \in R$

[c] all vectors of the form (a,b,c) where $a+b+c=1$

[d] all vectors of the form $(2,a,1)$ where $a \in R$

2. Which one of the following is not a vector space over C? CO1 K2

[a] R [b] $R-\{0\}$

[c] Z [d] N

3. What is the dimension of $C(R)$? CO2 K1

[a] 1 [b] 2

[c] 3 [d] 4

4. The number of elements in any two bases of a finite dimensional vector space is ____________ CO2 K2

[a] same [b] different

[c] infinite [d] Finite

5. Let V and W be vector spaces over the field F and T be a linear transformation from V into W and V is a finite-dimensional then which of the following is true? CO3 K1

[a] Rank (T) + nullity (T) $\leq$ dim V [b] rank (T) = dim V + 1

[c] dim V = rank (T) + nullity (T**)** [d] dim V = 0 only

6. A linear transformation $T: R^2 \to R^2$ such that $T(1,2)=(2,3)$ and $T(0,1)=(1,4)$ then which of the following is true? CO3 K2

[a] $\boldsymbol{T(x,y)=(y,-5x+4y)}$ [b] $T(x,y)=(2x,\frac{3}{2}y)$

[c] $T(x,y)=(x+1,5x+4y)$ [d] $T(x,y)=(|x|,y)$

7. If A = $\begin{bmatrix}5 & -6 & -6\\ -1 & 4 & 2\\ 3 & -6 & -4\end{bmatrix}$. Then rank $(A-2I)$ is ____________. CO4 K1

[a] 0 [b] -1

[c] 1 [d] none.

8. If V is a finite dimensional vector space and W is a subspace of V, then the invariance of W under T has a _______________ interpolation. CO4 K2

[a] matrix [b] zero polynomial

[c] polynomial [d] Hermitian matrix

9. Let u and v be eigen vectors of T corresponding to two distinct eigen values of T. Which of the following is true? CO5 K1

[a] $u+v$ can be an eigen value of T

[b] $\boldsymbol{u}+\boldsymbol{v}$ cannot be an eigen value of $\boldsymbol{T}$

[c] $u-v$ can be an eigen value of T

[d] $\{u,v\}$ is not a linearly independent set.

10. If T is diagonalizable and has a cyclic vector then T has __________. CO5 K2

[a] $n-1$ distinct eigen values [b] $\boldsymbol{n}$ distinct eigen values

[c] $n+1$ distinct eigen values [d] n^2 eigen values

CO(s)

Section – B **[5 x 6 = 30]** **K – Level**

Answer ALL the Questions

11.a) Let W and U be subspaces of $V(F)$ such that $W \subset U \subset V$ and let $f: V \rightarrow \frac{V}{W}$ be the quotient map. Show that $f(U)$ is a proper subspace of $\frac{V}{W}$. CO1 K2

[OR]

11.b) If L, M, N are three subspaces of a vector space V, such that $M \subseteq L$ then show that $L \cap (M+N) = (L \cap M) + (L \cap N) = M + (L \cap N)$. CO1 K2

12.a) Let V be a finite dimensional vector space and suppose S and T are two finite subsets of V such that S spans V and T is linearly independent. Prove that $O(T) \leq O(S)$. CO2 K3

[OR]

12.b) Let A be $n \times n$ symmetric matrix and suppose that R^n has the standard inner product. Prove that if $(u, uA) = (u, u)$ for all u in R^n, then $A = I$.. CO2 K3

13.a) Let T be a linear operator on finite dimensional vector space V. Suppose there is a linear operator U on V such that $TU = I$. Show that T is invertible and $T^{-1} = U$. CO3 K3

[OR]

13.b) Let T be linear operator on R^3, the matrix of which in the standard ordered CO3 K3 basis is A= $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 1 \\ -1 & 3 & 4 \end{bmatrix}$. Find a basis for the range of T and a basis for null space of T.

14.a) Let T be a linear operator on an n-dimensional space V. Prove that the characteristic and minimal polynomials for T have the same roots CO4 K3

[OR]

14.b) Prove that the minimal polynomial of a linear operator T divides its characteristics polynomial. CO4 K3

15.a) If T is an idempotent linear operator, then show that 0 or 1 are only eigen values of T and T is diagonalizable. CO5 K2

[OR]

15.b) Let T be a linear operator on a finite dimensional vector space V. Let$f(x)$ be the characteristic polynomial for T. Then $f(T) = 0$. CO5 K2

Section – C **[5 x 10 = 50]** **CO(s)** **K – Level**

Answer ALL the Questions

16. If S_1 and S_2 are subsets of V, then prove that CO1 K3

i)$S_1 \subseteq S_2 \Rightarrow L(S_1) \subseteq L(S_2)$

ii)$L(S_1 \cup S_2) = L(S_1) + L(S_2)$

iii)$L(L(S_1)) = L(S_1)$.

17. State and prove Gram- Schmidt Orthogonalisation process. CO2 K4

18. Let $T: V \rightarrow W$ and $S: W \rightarrow U$ be two linear transformations. Prove that CO3 K4

(i) If S and T are one-one onto then ST is one-one onto and $(ST)^{-1}$.

(ii) If ST is one-one then T is one-one.

(iii) If ST is onto then S is o

19. Obtain the eigen values, eigen vectors and eigen spaces of CO4 K4

$A = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$.

[OR]

20. Let T be a linear operator on a finite dimensional vector space $V(F)$.Suppose that the minimal polynomial for T decompose over F into a product of linear polynomials. Prove that there exists a diagonalizable operator D on V and a nilpotent operator N on V such that CO5 K3

i) $T = D + N$

ii) $DN = ND$. Further D and N are uniquely determined such that $T = D + N$ and $DN = ND$.

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc	**Date: 04.02.2022**
Course Code: 20PMAC32	**Time: 10 am To 1 pm**
Course Title : Measure Theory	**Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	What is the necessary condition satisfied for $m^*(A) \leq m^*(B)$? [a] $A \supseteq B$ [b] $A \subseteq B$ [c] $A \subset B$ [d] $A \supset B$	CO1	K1
2.	Which of the following property is not satisfied by the outer measure? [a] translation invariant [b] countable additivity [c] monotonicity [d] countable subadditivity	CO1	K2
3.	Which of the following ismeasurable? [a] monotone function [b] constant function [c] continuous function [d] all the above	CO2	K1
4.	The alternative form of $Ess \sup f$ is ______. [a] $- ess \inf(-f)$ [b] $ess \inf(-f)$ [c] $-ess\sup(-f)$ [d] $ess\sup(-f)$	CO2	K2
5.	Choose the correct statement if f and g be non-negative measurable function. [a] $\int f dx + \int g dx \neq \int (f + g)\, dx$ [b] $\int f dx + \int g dx = \int (f \mp g) dx$ [c] $\int f dx + \int g dx \leq \int (f + g)\, dx$ [d] $\int f dx + \int g dx \geq \int (f - g) dx$	CO3	K1
6.	Choose the correct one for any measurable set E and any non-negative measurable function f is said to be the integral of f over$E$. [a] $\int_E f\, dx = \int_E f\, \chi_E\, dx$ [b] $\int_E f\, dx = \int_E \emptyset\, dx$ [c] $\int_E f\, dx = sup \int_E \emptyset\, dx$ [d]$\int_E f\, dx = -\int_E f\, \chi_E\, dx$	CO3	K2

7. Let $a = \xi_0 < \xi_1 < \cdots < \xi_n = b$ be a partition$D$ of [a, b] then s_D is _______. CO4 K1

[a] $\sum_{i=1}^{n} M_i \, (\xi_i - \xi_{i-1})$ [b] $\sum_{i=1}^{n} m_i \, (\xi_i - \xi_{i-1})$

[c] $\sum_{i=1}^{n} M_i \, (\xi_{i-1} - \xi_i)$ [d] $\sum_{i=1}^{n} m_i \, (\xi_{i-1} - \xi_i)$

8. If $f(x) = \begin{cases} |x| & x \in Q \\ 2|x| & x \notin Q \end{cases}$ CO4 K2

then the value of $D^{-}f(0)$ is _______ .

[a] 2 [b] 1

[c] -1 [d] -2

9. If a ring is closed under the formation of countable unions then it is called _____. CO5 K1

[a] σ –ring [b] σ –algebra

[c] σ –field [d] σ –semi ring

10. A measureμ on $\mathcal{R}$is complete, if CO5 K2

[a] $E \in \Re$ [b] $F \subseteq E$

[c] μ(E) = 0 [d] all the above

Qn. No.	Section – B [5 x 4 = 20] Answer ALL the Questions	CO(s)	K – Level
11.a)	Show that for any set A and any $\epsilon > 0$, thereis an open set O containing A and such that $m^*(O) \leq m^*(A) + \epsilon$.	CO1	K3
	[OR]		
b)	Let $\mathcal{A}$ be a class of subsets of a space X, there exists a smallest σ –algebra $\mathcal{S}$ containing $\mathcal{A}$then prove that $\mathcal{S}$is a σ –algebra generated by $\mathcal{A}$.	CO1	K3
12.a)	Prove that continuous functions are measurable.	CO2	K2
	[OR]		
b)	Prove that the set of points on which a sequence of measurable functions $\{f_n\}$ converges, is measurable.	CO2	K2
13.a)	Show that $\int_1^\infty \frac{dx}{x} = \infty$	CO3	K3
	[OR]		
b)	Show that if f is integrable, then f is finite-valued almost everywhere.	CO3	K3
14.a)	Show that $f \in L(a+h, b+h)$and $f_h(x) \equiv f(x+h)$ then $f_h \in L(a,b)$ and $\int_{a+h}^{b+h} f dx = \int_a^b f_h \, dx.$	CO4	K3

	[OR]		
b)	If$f\ (x) = x \sin\left(\frac{1}{x}\right)$ for $x \neq 0, f(0) = 0$, find the four derivates at $x = 0$.	CO4	K3
15.a)	Let μ^* be the outer measure on $\mathcal{H}(\mathcal{R})$ defined by $\mu\ on\ \mathcal{R}$, then prove thatS^* contains $S(\mathcal{R})$ is the $\sigma -$ ring generated by $\mathcal{R}$.	CO5	K2
	[OR]		
b)	Prove that the limit of a point wise convergent sequence of measurable functions is measurable.	CO5	K2

Qn. No.	**Section – C [3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	Let $\{ E_i \}$ be a sequence of measurable sets. Prove that (i) if$E_1 \subseteq E_2 \subseteq \cdots$, then $m(\lim E_i) = \lim\ m(E_i)$. (ii)if $E_1 \supseteq E_2 \supseteq \cdots$, $and\ m(E_i) < \infty$ for each i, then $m(\lim E_i) = \lim m(E_i)$.	CO1	K4
17.	Let $\{ f_n \}$ be a sequence of measurable functions defined on the same measurable set. Then prove that (i) $\sup_{1 \le i \le n} f_i$ is measurable for each n, (ii) $\inf_{1 \le i \le n} f_i$ is measurable for each n, (iii) Sup f_n is measurable, (iv) inf f_n is measurable, (v) lim Sup f_n is measurable, (vi) lim inf f_n is measurable.	CO2	K2
18.	State and prove that Lebesgue's dominated convergence theorem for series.	CO3	K3
19.	Let f be bounded and measurable on a finite interval [a, b] and let $\in > 0$ then prove that there exist (i) a step function h such that $\int_a^b \lvert f - h \rvert\ dx < \in$, (ii) a continuous function g such that g vanishes outside a finite interval and $\int_a^b \lvert f - g \rvert\ dx < \in$.	CO4	K4
20.	Let $\{A_i\}$ be any sequence in a ring $\mathcal{R}$, then prove that there is a sequence $\{B_i\}$ of disjoint sets of $\mathcal{R}$ such that $B_i \subseteq A_i$ for each i and $\cup_{i=1}^{N} A_i = \cup_{i=1}^{N} B_i$ for each N, so that $\cup_{i=1}^{\infty} A_i = \cup_{i=1}^{\infty} B_i$.	CO5	K2

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS	**Date : 05.02.2022**
Course Code: 20PMAC33	**Time : 10 am To 1 pm**
Course Title: Topology	**Max. Marks : 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	Let X be any set, the collection of all subsets of $X$is called _______. [a] Indiscrete topology [b] Discrete topology [c] Trivial topology [d] Ring topology	CO1	K1
2.	Which of the following is true, if the topological space consists of the set of real number? [a] Co-finite topology [b] Co-countable topology [c] Co-complement topology [d] Usual topology	CO1	K2
3.	What is the $int(A)$if $= \{a,b,c,d,e\}$,$\Im = \{X,\emptyset,\{b\},\{a,d\},\{a,b,d\},\{a,c,d,e\}\}$ and$A = \{a,b,c\}$? [a] $\{a\}$ [b] $\{b\}$ [c] $\{c\}$ [d] $\{d\}$	CO2	K1
4.	What is A^o if$A \subseteq X$ in a topological space $(X,\Im)$? [a] A^o is closed [b] A^o is $\emptyset$ [c] A^o is X [d] A^o is open	CO2	K2
5.	Let (R , U) be usual topological space and $A , B \subseteq R$ where $A = (2,3)$ and $B = (4,5)$then ________. [a] A and B are separated [b] A and B may be separated [c] A and$B$ are separated [d] can't say	CO3	K1
6.	Let $(X,\Im_1)$ and $(Y,\Im_2)$ be two topological spaces then a function $f: X \to Y$ is said to be bicontinuous if $f$is ______. [a] Open [b] Continuous [c] Both a & b [d] Neither a nor b	CO3	K2

7.	Which of the following condition for cover of a subset ? [a] $A \in \{G_\alpha : \alpha \in \Lambda\}$ [b] $A \in \cup\{G_\alpha : \alpha \in \Lambda\}$ [c] $A \notin \cup\{G_\alpha : \alpha \in \Lambda\}$ [d] Both a and b	CO4	K1
8.	Which of the following is true? [a] A subset of a compact Hausdorff space is not compact iff it is closed [b] A subset of a compact Hausdorff space is compact iff it is open [c] A subset of a compact Hausdorff space is compact iff it is closed [d] A subset of a compact Hausdorff space is compact iff it is closed and open	CO4	K2
9.	Assertion (A): A topological space is T_1 space. Reason (R) : Every singleton subset $\{x\}$ of X is a $\Im$-closed set [a] Both A & R are true [b] A is true, R is false [c] A is false, R is true [d] Both A & R are false	CO5	K1
10.	Which one of the following is true? [a] Every second countable is separable. [b] Every subspace of a $T_o$space is $T_o$space [c] Every subspace of T_2space is T_2space [d] All the above	CO5	K2

Qn. No.	**Section – B [5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	If $(X, \Im)$ be a topological space in which $\{A_\alpha : \alpha \in \Lambda\}$ be an arbitrary collection of $\Im -$closed subsets of X. Prove that $\cap A_\alpha$ is also a $\Im -$closed set.	CO1	K2
	[OR]		
b)	Prove that $\Im = \{X, \emptyset, \{a\}, \{a, c\}, \{a, b, d\}\}$ is a topology for $X = \{a, b, c, d\}$and find all $\Im$-closed subsets of$X$.	CO1	K2
12.a)	Prove that every discrete topological space is Hausdorff.	CO2	K3
	[OR]		
b)	If $(X, \Im)$ be a topological space and A be a subset of X then prove that $\bar{A} = A \cup D(A)$.	CO2	K3
13.a)	Let $(X, \Im_1)$ and $(Y, \Im_2)$ be two topological spaces then prove that a function $f: X \rightarrow Y$ is $\Im_1 - \Im_2$ continuous or simply continuous iff the inverse image under f at every member of base B for $\Im_2$ is a$\Im_1$- open subset of X.	CO3	K3

	[OR]		
b)	Prove that in a topological space$(X,\Im)$, the subsets C and D of separated sets A and B respectivelyare also separated.	CO3	K3
14.a)	Show that co-finite topological space is compact.	CO4	K2
	[OR]		
b)	Let $(X,\Im)$ be compact space and f be a $\Im$-continuous mapping of Xinto R, then prove that f is bounded.	CO4	K2
15.a)	Show that every compact topological space is Lindelof but every Lindelof space is not necessarily compact.	CO5	K2
	[OR]		
b)	Show that every subspace of a T_o -space is a T_o –space.	CO5	K2
Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	Let X be a non-empty set and C be a collection of subsets of X. Then prove that there exists a family $\Im$ consisting of the members of C such $\Im$ is a topology for X and $\Im$ −closed subsets of X are members of C.	CO1	K2
17.	Let X be a non-empty set and for each $x \in X$. Let N_x be a non-empty collection of subsets of X satisfying the following conditions. (a) $N \in N_x \implies x \in N$ (b) $N \in N_x, M \in N_x \implies N \cap M \in N_x$ Let $\Im$-consists of the empty set and also the non-empty subsets A of X having the property that $x \in A$ implies that there exists an $N \subset N_x$ such that $x \in N \subset A$ then prove that $\Im$ is a topology.	CO2	K3
18.	Let A and B be two non-empty disjoint subsets of X and let $E = A \cup B$, then prove that (a) A and B are separated ⟺ each of A and B are closed in E (b) A and B are separated ⟺ each of A and B are open in E (c) $A$and$B$are separated ⟺ A and B are both open and closed in$E$.	CO3	K4
19.	Prove that a topological space $(X,\Im)$ is compact iff every basic open cover of X has a finite subcover.	CO4	K3
20.	Let B be any subset of a second countable space$X$. If C is an open cover of A then prove that C is reducible to a countable subcover.	CO5	K3

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G.T.N. ARTS COLLEGE (AUTONOMOUS)

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS **Date: 07.02.2022**
Course Code: 20PMAE31 **Time: 10 am To 1 pm**
Course Title: Graph Theory **Max. Marks 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	A connected graph G is Eulerian if ___________. a) Has no vertices of odd degree b) All vertices of odd degree c) Has no vertices of even degree d) All vertices of odd degree	CO1	K1
2.	How many of the following statements are correct? i) All cyclic graphs are complete graphs. ii) All complete graphs are cyclic graphs. iii) All paths are bipartite. iv) All cyclic graphs are bipartite. v) There are cyclic graphs which are complete. a) 1 b) 2 c) 3 d) 4	CO1	K2
3.	What is the value of $\lambda(G)$ for a disconnected graph G? a) 0 b) 1 c) 2 d) None of these	CO2	K1
4.	In a 2-connected graph G, any two longest cycles have at least _____ vertices in common. a) 0 b) 1 c) 2 d) 3	CO2	K2
5.	If M is a matching in G such that every vertex of G, M-saturated then M is called _____ matching. a) Perfect b) Proper c) Maximal d) Minimal	CO3	K1

6.	Every stable matching is a _____ matching in G.	CO3	K2
	a) Maximal b) Maximum		
	c) Minimal d) Minimum		
7.	The chromatic number of connected bipartite graph is _________.	CO4	K1
	a) 1 b) 2		
	c) 3 d) ≥ 4		
8.	A graph G is critical if _________ for every proper sub-graph H of G.	CO4	K2
	a) $\chi(H) < \chi(G)$ b) $\chi(H) > \chi(G)$		
	c) $\chi(H) = \chi(G)$ d) $\chi(G) = k$		
9.	K_n is planar if and only if ___________.	CO5	K1
	a) $n \leq 4$ b) $n \geq 4$		
	c) $n = 4$ d) $n \neq 5$		
10.	The Peterson graph is ________.	CO5	K2
	a) Planar b) Non-planar		
	c) Disconnected d) 2-regular		

Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Prove that the sum of degrees of a graph is twice the number of edges in it.	CO1	K3
	[OR]		
b)	Define path, walk and trail with suitable examples.	CO1	K3
12.a)	Show that every non-trivial loop-less connected graph has at least two vertices that are not cut vertices.	CO2	K3
	[OR]		
b)	Show that if G is simple and 3-regular, then prove that $k(G) = k'(G)$.	CO2	K3
13.a)	Explain Hamiltonian path and Hamiltonian cycle with examples.	CO3	K2
	[OR]		
b)	If G is a non Hamiltonian simple graph with $v \geq 3$, then prove that G is degree-majorised by some $C_{m,v}$.	CO3	K2
14.a)	If G is bipartite, then prove that $\chi' = \Delta$.	CO4	K2
	[OR]		

b)	Let G be a $k-$ critical graph with a 2-vertex cut $\{u, v\}$. Then prove that $G = G_1 \cup G_2$, where $G_i$is a $\{u, v\}$ $-$component of type i $(i = 1,2)$.	CO4	K2
15.a)	Prove that K_5 is non-planer.	CO5	K3
	[OR]		
b)	If G is a plane graph, then prove that $\sum_{f\in F} d(f) = 2\,\varepsilon.$	CO5	K3

Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	Write down union and disjoint of two graphs with suitable example.	CO1	K3
17.	Prove that an edge e of G is a cut edge of G if and only if e is contained in no cycle of G.	CO2	K4
18.	Show that in a bipartite graph, the number of edges in a maximum matching is equal to the number of vertices in a minimum covering.	CO3	K3
19.	Let G be a k $-$critical graph with a 2-vertex cut $\{u, v\}$. Then prove that $d(u) + d(v) \geq 3k - 5$.	CO4	K3
20.	i) Show that the Petersen graph is non-planar. ii) If G is a simple planar graph, then $\delta \leq 5$.	CO5	K4

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS **Date: 07.02.2022**
Course Code: 20PMAE32 **Time: 10 am To 1 pm**
Course Title: Number Theory **Max. Marks 60**

Qn. No.	**Section – A** [10 x 1 = 10] **Answer ALL the Questions**	CO(s)	K – Level
1.	Which one of the following is true if G.C.D$(a,b) = d$? a) d can be written in the linear combination of a and b such that $ax+by=d$ b) $a+b=d$ c) d can be written in the linear combination of a and b such that $ax-by=d$ d) All of the above	CO1	K1
2.	If n is a positive integer such that sum of all positive integer a satisfying $(a,n) = 1, 1 \leq a \leq n$ is equal to$240n$, then the number of summands ________. a) 120 b) 240 c) 480 d) 124	CO1	K2
3.	Which relation is satisfied for congruence on Z? a) Partial order relation b) Equivalence relation c) Anti symmetric relation d) Anti reflexive relation	CO2	K1
4.	Which of the following is true? a) $if\ a \equiv b\ (mod\ m), then\ a^n \equiv b^n\ (mod\ m)$ b) if $na \equiv nb\ (mod\ m)$ and $(m,n) = d$ then $a \equiv b\ (mod\ m\|d)$ c) if $na \equiv nb\ (mod\ m)$ and $(m,n) = 1$ then $a \equiv b\ (mod\ m)$ d) all of these	CO2	K2
5.	What is the quadratic residues modulo 5? a) 1 and 4 b) 1 and 5 c) 2 and 3 d) 1 and 3	CO3	K1

6.	What is the value of $\left(\frac{a}{p}\right)$ if $a = -1$ and$p = 11$? a) 1 b) -1 c) 32 d) -32	CO3	K2
7.	Find the value of $[-3.4]$? a) 3 b) 4 c) -3 d) -4	CO4	K1
8.	Find the value of$\sum_{n=1}^{\infty} \mu(n!)$? a) 1 b) 0 c) -1 d) ∞	CO4	K2
9.	The linear Diophantine equation $7x - 8y = 5$ has _______. a) Exactly one integer solution. b) Exactly two integer solution. c) Infinitely many integer solutions and the difference between any two values of x in the solutions is divisible by 8 d) Infinitely many integer solutions and the difference between any two values of x in the solutions is divisible by 7	CO5	K1
10.	The Diophantine equation$6x + 8y + 12z = 10$ is ________. a) Solvable b) Un solvable c) a or b d) Both a & b	CO5	K2

Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Prove that if$(a, m) = (b, m) = 1$, then $(ab, m) = 1$.	CO1	K2
	[OR]		
b)	Prove that every integer n greater than 1 can be expressed as a product of primes.	CO1	K2
12.a)	If $b \equiv c \ (mod\ m)$, then prove that$(b, m) = (c, m)$.	CO2	K2
	[OR]		
b)	State and prove Wilson's theorem.	CO2	K2
13.a)	If p denote an odd prime. Prove that if $(a, p) = 1$ then $\left(\frac{a^2 b}{p}\right) = \left(\frac{b}{p}\right)$.	CO3	K2

	[OR]		
b)	Estimate all primes p such that $\left(\frac{10}{13}\right) = 1$ by using Legendre Symbol.	CO3	K2
14.a)	Let x and y be real numbers then prove that (i) $[x+m] = [x] + m$, if m is an integer. (ii) $[x] + [y] \leq [x+y] \leq [x] + [y] + 1$.	CO4	K3
	[OR]		
b)	Let x and y be real numbers then prove that (i) if two integers are equally nearer to x, it is the smaller of the two. (ii) if n and a are positive integers, $[{}^{n}/_{a}]$ is the number of integers among 1,2,3,…,n that are divisible by a.	CO4	K3
15.a)	Find all solutions in integers of $2x + 3y + 4z = 5$ by using Diophantine equation.	CO5	K3
	[OR]		
b)	Find all solutions in integers of $6x + 8y + 12z = 10$ by using Diophantine equation.	CO5	K3

Qn. No.	**Section – C [3 x 10 = 30]** **Answer ANY THREE Questions**	**CO(s)**	**K – Level**
16.	State and prove the Unique factorization theorem.	CO1	K3
17.	Find all solutions of the congruence $9\,x \equiv 6\ (mod\ 15)$.	CO2	K3
18.	State and prove Gauss Lemma.	CO3	K3
19.	Show that if$f(n)$ be a multiplicative function and $F(n) = \sum_{d\mid n} f(d)$ then $F(n)$is multiplicative .	CO4	K4
20.	Estimate all solutions of $12x + 18y = 30$.	CO5	K3

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END SEMESTER EXAMINATION – NOVEMBER 2021

(UNDER OUTCOME BASED EDUCATION (OBE) PATTERN)

Programme: M.Sc., MATHEMATICS **Date: 08.02.2022**
Course Code: 20PMAN31 **Time: 10 am To 1 pm**
Course Title: Mathematics for Competitive Examinations **Max. Marks: 60**

Qn. No.	**Section – A** **[10 x 1 = 10]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
1.	Ravi's age after 15 years will be 5 times his age 5 years back. What is the present age of Ravi? a) 7 b) 8 c) 9 d) 10	CO1	K1
2.	Find the odd man out of 2,5,10,50,500,5000? a) 0 b) 5 c) 10 d) 5000	CO1	K2
3.	A can do a certain work in 12 days. B is 60% more efficient than A. How many days does B alone take to do the same job? a) 6 days b) $6\frac{1}{2}$ days c) 7 days d) $7\frac{1}{2}$ days	CO2	K1
4.	A car moves at the speed of 80 km/hr. What is the speed of the car in meters per second? a) 8 m/sec b) $20\frac{1}{9}$ m/sec c) $22\frac{2}{9}$ m/sec d) 22 m/sec	CO2	K2
5.	What is 25% of 25% equal to? a) 0.00625 b) 0.0625 c) 0.625 d) 6.25	CO3	K1
6.	Mean proportional between a and b is _________. a) ab b) $a + b$ c) $a - b$ d) $\sqrt{ab}$	CO3	K2

7.	A man invests in a 16% stock at 128. The interest obtained by him is _______. a) 8% b) 12% c) 12.5% d) 16%	CO4	K1
8.	A bag contains nine yellow balls, three white balls and four red balls. In how many ways can two balls be drawn from the bag? $a)\ 9C_2$ $b)\ 3C_2$ $c)\ 16C_2$ $d)\ 12C_2$	CO4	K2
9.	If at least 60% marks in Physics are required for pursuing higher studies in Physics, how many students will be eligible to pursue higher studies in Physics? a) 27 b) 32 c) 34 d) 41	CO5	K1
10.	What is an approximate percentage decrease in production from 1993 to 1994? a) 87.5% b) 37.5% c) 9.09% d) None of these	CO5	K2

Qn. No.	**Section – B** **[5 x 4 = 20]** **Answer ALL the Questions**	**CO(s)**	**K – Level**
11.a)	Rohit was 4 times as old as his son 8 years ago. After 8 years, Rohit will be twice as old as his son. What are their present ages?	CO1	K3
	[OR]		
b)	A cricketer has a certain average for 10 innings. In the eleventh inning, he scored 108 runs, thereby increasing his average by 6 runs. What is the new average of the cricketer?	CO1	K3
12.a)	While covering a distance of 24 km, a man noticed that after walking for 1 hour and 40minutus, the distance covered by him was $5/7$ of the remaining distance. What was his speed in meter per second?	CO2	K2
	[OR]		
b)	Two pipes A and B can fill a tank in 24 min and 32 min respectively. If both the pipes are opened simultaneously, after how much time B should be closed so that the tank is full in 18 minutes?	CO2	K2

13.a) The value of a machine depreciates at the rate of 10% per annum. If its present value is Rs.1,62,000, what will be its worth after 2 years? What was the value of the machine 2 years ago? CO3 K2

[OR]

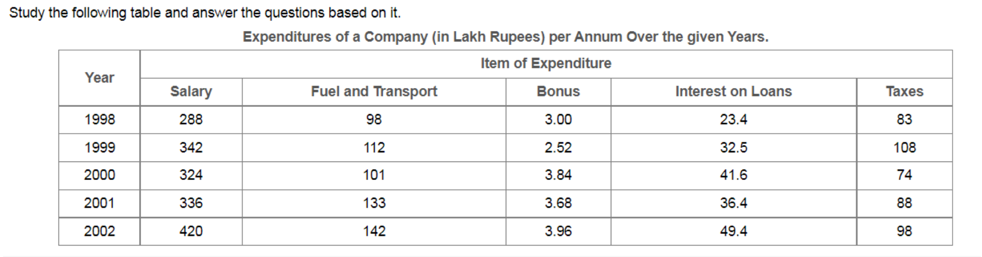
b) By mixing two brands of tea and selling the mixture at the rate of Rs. 117 per kg, a shopkeeper makes a profit of 18%. If to every 2 kg of one brand costing Rs. 200 per kg, 3kg of the other brand is added, then how much per kg does the other brand cost? CO3 K2

14.a) Which is better investment, 12% stock at par with an income tax at the rate of 5 paise per rupee or $14\frac{2}{7}$ % stock at 120 free from income tax? CO4 K2

[OR]

b) A committee has 5 men and 6 women. What are the number of ways of selecting 2 men and 3 women from the given committee? CO4 K2

15.a) CO5 K3



Study the following table and answer the questions based on it.

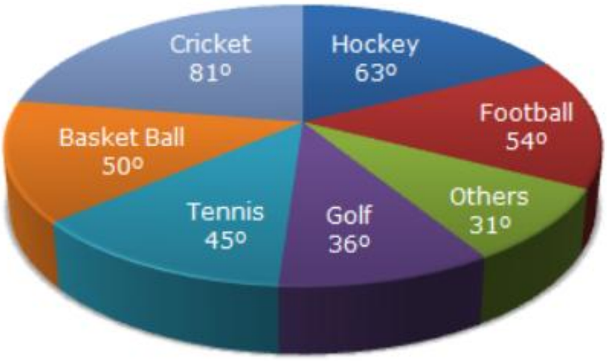
Expenditures of a Company (in Lakh Rupees) per Annum Over the given Years.

Year	Item of Expenditure				
	Salary	Fuel and Transport	Bonus	Interest on Loans	Taxes
1998	288	98	3.00	23.4	83
1999	342	112	2.52	32.5	108
2000	324	101	3.84	41.6	74
2001	336	133	3.68	36.4	88
2002	420	142	3.96	49.4	98

1. What is the average amount of interest per year which the company had to pay during this period?
2. The total amount of bonus paid by the company during the given period is approximately what percent of the total amount of salary paid during this period?
3. Total expenditure on all these items in 1998 was approximately what percent of the total expenditure in 2002?
4. The total expenditure of the company over these items during the year 2000 is?

[OR]

b) The circle-graph given here shows the spendings of a country on various sports during a particular year. Study the graph carefully and answer the questions given below it. CO5 K3



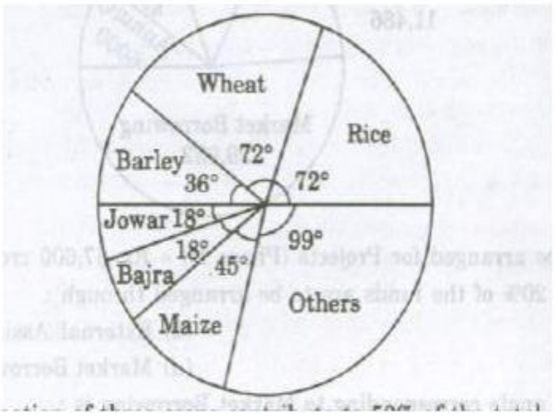
1. How much percent more is spent on Hockey than that on Golf?
2. If the total amount spent on sports during the year be Rs. 1,80,00,000. Find the amount spent on Basketball exceeds on Tennis?
3. How much percent less is spent on Football than that on Cricket?
4. If the total amount spent on sports during the year was Rs. 2 crores, What is the amount spent on Cricket and Hockey together?

Qn. No.	**Section – C** **[3 x 10 = 30]** **Answer ANY THREE Questions**	CO(s)	K – Level
16.	Tanya’s grandfather was 8 times older to her 16 years ago. He would be 3 times of her age 8 years from now. Eight years ago, What was the ratio of Tanya’s age to that of her grandfather?	CO1	K3
17.	Two pipes can fill a cistern in 14 hours and 16 hours respectively. The pipes are opened simultaneously and it is found that due to leakage in the bottom it took 32 minutes more to fill the cistern. When the cistern is full, in what time will the leak empty it?	CO2	K4
18.	Mr. Jones gave 40% of the money he had, to his wife. He also gave 20% of the remaining amount to each of his three sons. Half of the amount now left was spent on miscellaneous items and the remaining amount of Rs. 12,000 was deposited in the bank. How much money did Mr. Jones have initially?	CO3	K3

19. A man sells Rs.5000, 12 % stock at 156 and invests the proceeds party in 8 % stock at 90 and 9 % stock at 108. He hereby increases his income by Rs. 70. How much of the proceeds were invested in each stock? CO4 K3

20. The pie-chart provided below gives the distribution of land (in a village) under various food crops. Study the pie-chart carefully and answer the questions that follow. CO5 K3

DISTRIBUTION OF AREAS (IN ACRES) UNDER VARIOUS FOOD CROPS



1) Which combination of three crops contribute to 50% of the total area under the food crops?

2) If the total area under jowar was 1.5 million acres, then what was the area (in million acres) under rice?

3) If the production of wheat is 6 times that of barley, then what is the ratio between the yield per acre of wheat and barley?

4) If the yield per acre of rice was 50% more than that of barley, then the production of barley is what percent of that of rice?

5) If the total area goes up by 5%, and the area under wheat production goes up by 12%, then what will be the angle for wheat in the new pie-chart?