LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Differential Equations **Class : I year I Sem**

Name of the Topic : Differential Equations of first order and first degree

Hours required : 12 Hrs

Learning Objectives : Students will be able to solve

(i) the exact differential equations
(ii) the Differential equations using integrating factors
(iii) the Linear differential equations of first order and first degree

Previous Knowledge to be reminded : Differentiation and Integration formulae learnt in Intermediate, variable seperable method, substitution method, etc.

Topic Synopsis :

- Exact Differential equation : An equation of the form $M(x, y)dx + N(x, y)dy = 0$ is said to be an exact if there exists a function $f(x, y)$ having continuous first order partial derivatives such that $d(f(x, y)) = Mdx + Ndy$.

- The necessary and sufficient condition for the differential equation $Mdx + Ndy = 0$ to be exact is $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$

- The General solution of given exact differential equation $Mdx + Ndy = 0$ is

$$\int\limits_{(y-constant)} Mdx + \int (terms\ of\ N\ not\ containing\ x)dy = 0$$

- If $Mdx + Ndy = 0$ is not exact and is a homogeneous differential equation with $Mx + Ny \neq 0$, then the Integrating Factor is $\frac{1}{Mx+Ny}$.

- If $Mdx + Ndy = 0$ is not exact and is of the form $yf(xy)dx + xg(xy)dy = 0$ with $Mx - Ny \neq 0$, then the Integrating Factor is $\frac{1}{Mx-Ny}$.

- If there exists a continuous single variable function $f(x)$ such that $\frac{1}{N}\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right) = f(x)$ or K(real number), then $e^{\int f(x)dx}$ is an integrating factor of $Mdx + Ndy = 0$
- Linear Differential equation: An equation of the form $\frac{dy}{dx} + Py = Q$ where $P,\ Q$ are functions of x alone or constants is called a LDE of order one in y.

  Its General Solution is $ye^{\int Pdx} = \int\left[Qe^{\int Pdx}\right]dx + c$

- An equation of the form $\frac{dy}{dx} + Py = Qy^{n}$ where $P,\ Q$ are functions of x alone or constants and $n\neq 0, 1$ is a real number, is called a Bernoulli's equation.

Examples/Illustrations :

- Exact DE $ydx + \left(2xy - e^{-2y}\right)dy = 0$
- Linear DE $\frac{dy}{dx} + x^{2}y = x$

Additional Inputs : Applications of Differential Equations **-** Newton's law of cooling and law of natural growth and decay.

Teaching Aids used : Black Board, LMS videos, Google Classroom

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by N. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.
2. Ordinary and Partial differential equations by Raisinghania, published by S. Chand & Company, New Delhi.

Student Activity planned after teaching :

- Summerization of important methods
- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-1

Any other activity : Quiz on formulae and methods

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Differential Equations **Class : I year I Sem**

Name of the Topic : Orthogonal Trajectories and DE's of first order but not of first degree

Hours required : 12 Hrs

Learning Objectives : Students will be able to

(i) find the orthogonal trajectories of given family of curves in cartesian form and in polar coordinates
(ii) solve the DE's of first order but not of first degree by choosing one of the methods from "solvable for p", "solvable for x or y" and "clairaut's form".

Previous Knowledge to be reminded : Methods learnt in Unit-I

Topic Synopsis :

Orthogonal Trajectory: Any curve which cuts every member of a given family of curves at 90° (orthogonally) is called orthogonal trajectory of the given curve.

For the given differential equation $f\left(x, y, y^{'}\right) = 0$, the orthogonal trajectory is obtained by solving $f\left(x, y, \frac{-1}{y^{'}}\right) = 0$.

In polar coordinates (r, θ), the orthogonal trajectory of $f\left(r, \theta, \frac{dr}{d\theta}\right) = 0$ is obtained by solving $f\left(r, \theta, -r^{2}\frac{d\theta}{dr}\right) = 0$.

The General solution of the first degree differential equation always contain only one arbitrary constant.

Method of solving equations solvable for x:

Let $f(x, y, p) = 0$ be the given differential equation. If this cannot be split into rational and linear factors and is of first degree in x, then it can be solved for x. The given equation can be written in the form $x = F(y, p)$. Differentiating this w.r.t y, gives an equation of the form $\frac{1}{p} = g\left(y, p, \frac{dp}{dy}\right)$ whose solution is of the form $\emptyset(y, p, c) = 0$. Eliminating p gives general solution $\psi(x, y, c) = 0$.

Method of solving equations solvable for y:

Let $f(x, y, p) = 0$ be the given differential equation. If this cannot be split into rational and linear factors and is of first degree in y, then it can be solved for y. The given equation can be written in the form $y = F(x, p)$. Differentiating this w.r.t x, gives an equation of the form $p = g\left(x, p, \frac{dp}{dy}\right)$ whose solution is of the form $\emptyset(x, p, c) = 0$. Eliminating p gives general solution $\psi(x, y, c) = 0$.

The differential equation of the form $y = xp + f(p)$ is called Clairaut's equation. Its solution is $y = xc + f(c)$.

Examples/Illustrations : Orthogonal trajectory of $r = 2a\, cos\theta$ is $r = 2c\, sin\theta$.

Additional Inputs : -

Teaching Aids used : Graphing calculator, Black Board, LMS videos

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by N. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.
2. Ordinary and Partial differential equations by Raisinghania, published by S. Chand & Company, New Delhi.

Student Activity planned after teaching :

- Summerization of important methods
- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-2

Any other activity : Slip test on methods

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Differential Equations **Class : I year I Sem**

Name of the Topic **:** Higher order Linear differential equations - I

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to find the Complementary function and Particular integral of Linear differential equations of higher order.

Previous Knowledge to be reminded **:** Methods of finding roots of single variable equation, reducing rational functions into partial fractions.

Topic Synopsis **:**

- Let the differential operator $\frac{d}{dx}$ is denoted by D and the differential operators $\frac{d^2}{dx^2}, \frac{d^3}{dx^3}, \ldots, \frac{d^n}{dx^n}$ be denoted respectively by $D^2,\ D^3, \ldots,\ D^n$.

- Hence $f(D)y = D^n y + P_1 D^{n-1} y + P_2 D^{n-2} y + \ldots + P_n y$
$$= \frac{d^n y}{dx^n} + P_1 \frac{d^{n-1}}{dx^{n-1}} + P_2 \frac{d^{n-2}}{dx^{n-2}} + \ldots + P_n y$$

- The LDE $f(D) = Q$ is called non-homogeneous if $Q \neq 0$.
Its General solution is $y = C.F + P.I$
$$= Complementary\ Function + Particular\ Integral$$

- For $f(D) = 0$, the auxilliary equation is $f(m) = 0$.

Roots of auxilliary equation	Complementary function
$m_1, m_2, m_3\ (real)$	$y = c_1 e^{m_1 x} + c_2 e^{m_2 x} + c_3 e^{m_3 x}$
$m_1, m_1, m_1\ (real)$	$y = (c_1 + c_2 x + c_3 x^2) e^{m_1 x}$

$a \pm ib (complex\ conjugates)$	$y = e^{ax}(c_1 cosbx + c_2 sinbx)$

- P.I of the differential equation $f(D) = Q$ is $\frac{1}{f(D)}Q$.

- $P.I = \frac{1}{D-\alpha}Q(x) = e^{\alpha x}\int Q(x)e^{-\alpha x}dx$

- When $Q(x) = be^{ax}$,

$P.I = \frac{1}{f(D)}be^{ax} = \{b\frac{1}{f(a)}e^{ax}$ $\quad if \quad f(a) \neq 0$ $\quad b\frac{1}{\varphi(a)}\frac{x^k}{k!},\ \varphi(a) \neq 0\ when\ a$

- When $Q(x) = sinbx\ or\ cosbx$, replace D^2 by $-\ b^2$ to calculate $P.I.$

Case (i): When $f(D) = \emptyset\left(D^2\right)$ and $\emptyset\left(-\ b^2\right) \neq 0$

$P.I = \frac{1}{f(D)}sinbx = \frac{1}{\emptyset\left(D^2\right)}sinbx = \frac{1}{\emptyset\left(-b^2\right)}sinbx$ and

$P.I = \frac{1}{f(D)}cosbx = \frac{1}{\emptyset\left(D^2\right)}cosbx = \frac{1}{\emptyset\left(-b^2\right)}cosbx$

Case (ii): When $f(D) = \emptyset\left(D^2\right)$ and $\emptyset\left(-\ b^2\right) = 0$,

then $\left(D^2 + b^2\right)$ is a factor of $\emptyset\left(D^2\right)$ and hence

$f\left(D^2\right) = \left(D^2 + b^2\right)F(D^2)$ where $F\left(-\ b^2\right) \neq 0$.

$P.I = \frac{1}{f(D)}sinbx = \frac{1}{\left(D^2+b^2\right)F\left(D^2\right)}sinbx = \frac{1}{F\left(-b^2\right)}\frac{1}{D^2+b^2}sinbx$

$P.I = \frac{1}{f(D)}cosbx = \frac{1}{\left(D^2+b^2\right)F\left(D^2\right)}cosbx = \frac{1}{F\left(-b^2\right)}\frac{1}{D^2+b^2}cosbx$

Case (iii): When $f(D) = \emptyset_1\left(D^2\right) + D\emptyset_2\left(D^2\right)$, then $f(D) = p + qD$ and hence

$\frac{1}{f(D)} = \frac{p-qD}{p^2-q^2D}sinbx = \frac{p-qD}{p^2+q^2b^2}sinbx = \frac{1}{p^2+q^2b^2}(psinbx - bqcosbx)$

$\frac{1}{f(D)} = \frac{p-qD}{p^2-q^2D}sinbx = \frac{p-qD}{p^2+q^2b^2}sinbx = \frac{1}{p^2+q^2b^2}(pcosbx + bqsinbx)$

- $\frac{1}{D^2+b^2} sinbx = -\frac{x}{2b} cosbx$
- $\frac{1}{D^2+b^2} cosbx = \frac{x}{2b} sinbx$

Examples/Illustrations : $\left(D^2 + a^2\right) = \sec sec\, ax$

Additional Inputs : Applications to Electrical Circuits

Teaching Aids used : Black Board

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by N. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.
2. Ordinary and Partial differential equations by Raisinghania, published by S. Chand & Company, New Delhi.

Student Activity planned after teaching :

- Summerization of important methods
- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-3

Any other activity : Group discussion

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Differential Equations **Class : I year I Sem**

Name of the Topic **:** Higher order Linear differential equations - II

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to know the shorter methods to find the Particular integral of Linear Differential equations of higher order.

Previous Knowledge to be reminded **:** Finding roots of single variable equations, Binomial expressions, methods learnt in unit -3.

Topic Synopsis **:**

- To find $\frac{1}{f(D)}x^{k}$, take out the lowest degree term common from $f(D)$ leaving the remainder factor as $[1\pm\varphi(D)]$. Take $[1\pm\varphi(D)]$ to the numerator and expand in ascending powers of D upto D^{k} and operate on x^{k}.

- $\frac{1}{f(D)}e^{ax}V(x) = e^{ax}\frac{1}{f(D+a)}V(x)$

- $\frac{1}{f(D)}xV = x\frac{1}{f(D)}V - \frac{f'(D)}{[f(D)]^{2}}V$

Examples/Illustrations : $\left(D^2 - 4D + 4\right) = x^3$

Additional Inputs : Solving simultameous Differential Equations

Teaching Aids used : Black Board

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by N. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.
2. Ordinary and Partial differential equations by Raisinghania, published by S. Chand & Company, New Delhi.

Student Activity planned after teaching :

- Summerization of important methods
- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-4

Any other activity : Slip Test

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Differential Equations **Class : I year I Sem**

Name of the Topic **:** Higher order Linear differential equations - III

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to apply the method of variation of parameters to Linear differential equations of higher order.

Previous Knowledge to be reminded **:** Methods learnt in Units III & IV

Topic Synopsis **:**

Method of Variation of Parameters for $\frac{d^2y}{dx^2} + P\frac{dy}{dx} + Qy = R$:

Let the Complementary Function be $y = c_1u(x) + c_2v(x)$.

Then the Particular Integral is $A(x)u(x) + B(x)v(x)$ where

$A(x) = \int \frac{-vR}{uv_1 - vu_1}dx$ and $B(x) = \int \frac{uR}{uv_1 - vu_1}dx$

Finally, the Generally solution is $y = C.F + P.I$

Cauchy-Euler equation of order n is

$$\left(x^nD^n + P_1x^{n-1}D^{n-1} + \dots + P_n\right)y = Q(x)$$

Method of solving: Put $x = e^z$ and let $\theta = \frac{d}{dz}$.

Then $xD = \theta$,

$x^2D^2 = \theta(\theta - 1)$,

$x^3D^3 = \theta(\theta - 1)(\theta - 2)$ and so on.

Legendre's Linear equation of order n is

$$(ax + b)^n D^n y + P_1 (ax + b)^{n-1} D^{n-1} y + ... + P_n y = Q(x)$$

Method of solving: Put $ax + b = e^z$ and let $\theta = \frac{d}{dz}$.

Then $(ax + b)D = \theta$,

$(ax + b)^2 D^2 = \theta(\theta - 1)$,

$(ax + b)^3 D^3 = \theta(\theta - 1)(\theta - 2)$ and so on.

Examples/Illustrations : $\left(D^2 + 1\right) = cosecx$

C.F $y_c = c_1 cosx + c_2 sinx$ and P.I $y_p =- xcosx + (log|sinx|)sinx$

Additional Inputs : -

Teaching Aids used : Black Board

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by N. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.
2. Ordinary and Partial differential equations by Raisinghania, published by S. Chand & Company, New Delhi.

Student Activity planned after teaching :

- Summerization of important methods
- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-5

Any other activity : Seminar

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Three Dimensional Analytical Solid Geometry **Class : I year II Sem**

Name of the Topic : The Plane

Hours required : 12 Hrs

Learning Objectives : Students will be able to

(i) find the equation of a plane with the given conditions
(ii) check if the planes are parallel or perpendicular
(iii) calculate the angle between two given planes

Previous Knowledge to be reminded : Basics of 3D-geometry, direction cosines, direction ratios, etc.

Topic Synopsis :

- The equation to every plane is of the first degree in x, y, z and its normal form is $lx + my + nz = p$, where l, m, n are the $d.c's$ of the normal to the plane and $p \geq 0$ is the distance of the origin to the plane.
- Angle between two planes $a_1x + b_1y + c_1z + d_1 = 0$ and $a_2x + b_2y + c_2z + d_2 = 0$ is $\theta = cos^{-1}\left(\frac{a_1a_2+b_1b_2+c_1c_2}{\sqrt{\left(a_1^2+b_1^2+c_1^2\right)\left(a_2^2+b_2^2+c_2^2\right)}}\right)$
- Two planes are perpendicular if $a_1a_2 + b_1b_2 + c_1c_2 = 0$ and the two planes are parallel if $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$.
- $H \equiv ax^2 + by^2 + cz^2 + 2fyz + 2gxz + 2hxy = 0$ represents a pair of planes or a plane if $D = |a\ h\ g\ h\ b\ f\ g\ f\ c\ | = 0$; $f^2 \geq bc,\ g^2 \geq ac,\ h^2 \geq ab$.

**Examples/Illustrations : **Examples illustrated using Geogebra

Additional Inputs :

Teaching Aids used : Black Board, Graphing Calculator-Geogebra

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by V. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-1

Any other activity : -

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Three Dimensional Analytical Solid Geometry **Class : I year II Sem**

Name of the Topic : The Line

Hours required : 12 Hrs

Learning Objectives : Students will be able to

(i) find the equations of a line with on given conditions
(ii) calculate the point of intersection of a line and a plane
(iii) calculate distance between a line and a plane
(iv) calculate the shortest distance and its line equation between two non-intersecting lines

Previous Knowledge to be reminded : concept of planes

Topic Synopsis :

- Equation to the line passing through the point (x_1, y_1, z_1) and having d.c's l, m, n are $\frac{x-x_1}{l} = \frac{y-y_1}{m} = \frac{z-z_1}{n} = r$, r being any real number.
- If θ is the acute angle between the line $\frac{x-x_1}{l} = \frac{y-y_1}{m} = \frac{z-z_1}{n} = r$ and the plane $ax + by + cz + d = 0$, then $sin\theta = \pm\frac{al+bm+cn}{\sqrt{(a^2+b^2+c^2)(l^2+m^2+n^2)}}$
- The line is perpendicular to the plane if $\frac{a}{l} = \frac{b}{m} = \frac{c}{n}$
- The line is parallel to the plane if $al + bm + cn = 0$.
- Any two non-parallel and non-intersecting lines are called skew lines. Skew lines are non-coplanar and the distance between them is called skew distance (S.D).

Examples/Illustrations **:** Examples illustrated using Geogebra

Additional Inputs **:**

Teaching Aids used **:** Black Board, Geogebra

References cited **:**

1. A text book of Mathematics for B.A/B.Sc Vol 1 by V. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-2

Any other activity **:** Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Three Dimensional Analytical Solid Geometry **Class : I year II Sem**

Name of the Topic : Sphere

Hours required : 20 Hrs

Learning Objectives : Students will be able to

(i) know the equation of a sphere and its basic concepts
(ii) find the pole and polar for a given pole
(iii) find the conjugate planes for a sphere

Previous Knowledge to be reminded : Circles learnt in their intermediate

Topic Synopsis :

- Equation to the sphere with centre (x_1, y_1, z_1) and radius a is $(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 = a^2$
- General equation of a sphere is $S \equiv x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0$ where $(-u, -v, -w)$ is the centre and $r = \sqrt{u^2 + v^2 + w^2 - d}$
- If a plane and a sphere intersects, the locus of the set of points of intersection is a circle.
- S is a sphere and B is a point. The locus of the points so that the plane of contact of each point w.r.t S passes through B is a plane called the polar plane of B w.r.t S. B is called the pole of the polar plane and its equation is $S_1 = 0$.
- S is a sphere. If A, B are two points such that the polar plane of B w.r.t S passes through A, then A, B are called conjugate points w.r.t S. The polar planes of A and B are called conjugate planes.
- The locus of points each of whose powers w.r.t two non-concentric spheres are equal is a plane called the radical plane of the two spheres. Equation of the radical plane of the spheres $S = 0, S' = 0$ is $S - S' = 0$.

- A system of spheres such that any two spheres of the system have the same radical plane is called a coaxal system of planes.

Examples/Illustrations **:** Examples illustrated using Geogebra

Additional Inputs **:** -

Teaching Aids used **:** Black Board, Geogebra

References cited **:**

1. A text book of Mathematics for B.A/B.Sc Vol 1 by V. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-3

Any other activity **:** Unit test

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Three Dimensional Analytical Solid Geometry **Class : I year II Sem**

Name of the Topic : Cones

Hours required : 16 Hrs

Learning Objectives : Students will be able to

(i) know the definition of a cone and its properties
(ii) find the right circular cone under given condition

Previous Knowledge to be reminded : Planes and Lines

Topic Synopsis :

- Let S be a set of points in space. If there exists a point V in S such that $P \in S \Longrightarrow \overleftrightarrow{VP} \subset S$, then S is called the cone and V is said to be the vertex of the cone. $\overleftrightarrow{VP}$ is called a generator of the cone.
- The general equation of the cone of second degree which pass through the coordinate axes is $fyz + gzx + hxy = 0$.
- Let S be the set of lines concurrent at V and C be a curve not containing V. If $P \in S \Longrightarrow \overleftrightarrow{VP} \subset S$, then S is called the cone with vertex at V and C is called the base curve or guiding curve. $\overleftrightarrow{VP}$ is called a generator of the cone.
- Let S be the set of lines concurrent at V. If there exists a line L passing through V such that for a line , $M \in S \Longrightarrow (L, M) = \theta$, then S is called a right circular cone with vertex at V.
- The locus of the lines perpendicular to the tangent planes of the cone $E(x, y, z) = 0$ and passing through its vertex is the cone, called the reciprocal cone.

**Examples/Illustrations : **Examples illustrated using Geogebra

Additional Inputs : -

Teaching Aids used : Black Board, Geogebra

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by V. Krishna Murthy & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-4

Any other activity : Seminar

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Linear Algebra **Class : II year IV Sem**

Name of the Topic **:** Vector Spaces-I

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to

(i) Understand the concept of vector spaces and vector subspaces
(ii) Form a Linear span with a given subset of a vector space
(iii) See if a non-empty subset of a given set is Linearly Dependent or Linearly independent.

Previous Knowledge to be reminded **:** Group theory basic properties, solving linear equations

Topic Synopsis **:**

- Vector space: Let V be a non-empty set whose elements are called vectors. Let F be any set whose elements are called scalars where $(F, +,.)$ is a field. Then the set V is said to be a vector space if
  (i) $(V, +)$ is an abelian group
  (ii) $a\alpha \in V\ \forall\ a \in F,\ \alpha \in V$
  (iii) $a(\alpha + \beta) = a\alpha + a\beta\ \forall\ a \in F,\ \alpha, \beta \in V$
  (iv) $(a + b)\alpha = a\alpha + b\alpha\ \forall\ a, b \in F,\ \alpha \in V$
  (v) $(ab)\alpha = a(b\alpha)\ \forall\ a, b \in F,\ \alpha \in V$
  (vi) $1\alpha = \alpha\ \forall\ \alpha \in F$ where 1 is the unity element of F.

- Vector subspace: Let $V(F)$ be a vector space and $W \subseteq V$. Then W is said to be a subspace of V of W itself is a vector space over F with the same operations of vector addition and scalar multiplication in V.

- Let $V(F)$ be a vector space and $W \subseteq V$. Then the necessary and sufficient conditions for W to be a subspace of V is $a \in F$ and $\alpha, \beta \in W$ implies $a\alpha + \beta \in W$.

- If W_1 and W_2 are two subspaces of a vector space $V(F)$, then $W_1 \cup W_2$ is a subspace of $V(F)$ iff $W_1 \subseteq W_2$ or $W_2 \subseteq W_1$.

- If S and T are two subsets of a vector space $V(F)$, then $L(S \cup T) = L(S) + L(T)$.

- Let $V(F)$ be a vector space. If $\alpha_1, \alpha_2, \ldots, \alpha_n$ are non-zero vectors of V then either they are linearly independent for some α_k, $2 \le k \le n$ is a linear combination of the preceeding ones $\alpha_1, \alpha_2, \ldots, \alpha_{k-1}$.

Examples/Illustrations : C is the field of complex numbers and R is the field of real numbers. Then $C(R)$ is a vector space and $R(C)$ is not a vector space.

Additional Inputs : -

Teaching Aids used : Black Board, LMS videos

References cited :

1. A text book of Mathematics of B.Sc Mathematics, Vol III, Linear Algebra by V.Venkateswara Rao & Others, published by S.Chand & Company, New Delhi.
2. Linear Algebra by J.N.Sharma and A.R.Vashista, published by Krishna Prakashan Mandir, Meerut.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-1

Any other activity : Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Linear Algebra **Class : II year IV Sem**

Name of the Topic : Vector Spaces-II

Hours required : 12 Hrs

Learning Objectives : Students will be able to understand the concept of a basis and hence find the dimension of a vector space

Previous Knowledge to be reminded : Linear Dependence, Linear Independence, Group theory basic properties

Topic Synopsis :

- Basis: A subset S of a vector space $V(F)$ is said to be the basis of V if
  - (i) S is linearly independent and
  - (ii) the linear span of S is V.
- Every finite dimensional vector space has a basis.
- Invariance Theorem: Let $V(F)$ be a finite dimensional vector space. Then any two bases of V have the same number of elements.
- Dimension: Let $V(F)$ be a finite dimensional vector space. The number of elements in any basis of V is called the dimension of V and is denoted by $dimV$.
- Let W_1 and W_2 be two subspaces of a finite dimensional vector space $V(F)$. Then

  $\dim dim\left(W_1 + W_2\right) = dimW_1 + dimW_2 - dim(W_1 \cap W_2)$
- Dimension of a Quotient space: Let W be a subspace of a finite dimensional vector space $V(F)$. Then $dim\frac{V}{W} = dimV - dimW$.

Examples/Illustrations : The set of vectors $e_1 = (1, 0, 0, ..., 0)$,

$e_2 = (0, 1, 0, ..., 0), ..., e_n = (0, 0, 0, ..., 1)$ forms a basis of $V_n(F)$.

Additional Inputs : -

Teaching Aids used **:** Black Board, LMS videos

References cited :

1. A text book of Mathematics of B.Sc Mathematics, Vol III, Linear Algebra by V.Venkateswara Rao & Others, published by S.Chand & Company, New Delhi.
2. Linear Algebra by J.N.Sharma and A.R.Vashista, published by Krishna Prakashan Mandir, Meerut.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-2

Any other activity : Slip test

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Linear Algebra **Class : II year IV Sem**

Name of the Topic : Linear Transformations

Hours required : 12 Hrs

Learning Objectives : Students will be able to find the range and null space of a given transformation.

Previous Knowledge to be reminded : Vector spaces, basis and dimension

Topic Synopsis :

- Linear Transformation: Let $U(F)$ and $V(F)$ be two vector spaces. Then the function $T: U\rightarrow V$ is called a linear transformation of U into V if

$$T(a\alpha + b\beta) = aT(\alpha) + bT(\beta)\ \forall\ a, b\in F,\ \alpha, \beta\in U.$$

- Range: Let $U(F)$ and $V(F)$ be two vector spaces and $T: U\rightarrow V$ be a linear transformation. The range of T is defined to be the set

$$R(T) = \{T(\alpha): \alpha\in U\}.$$

- Null space: Let $U(F)$ and $V(F)$ be two vector spaces and $T: U\rightarrow V$ be a linear transformation. Then the null space of T is defined to be the set

$$N(T) = \left\{\alpha\in U: T(\alpha) = 0^{'}\in V\right\}.$$

- Rank of T, denoted by $\rho(T)$ is the dimension of range space and Nullity of T, denoted by $\vartheta(T)$ is the dimension of null space.
- Rank-Nullity theorem: Let $U(F)$ and $V(F)$ be two vector spaces and $T: U\rightarrow V$ be a linear transformation. Let U be a finite dimensional, then $\rho(T) + \vartheta(T) = dimU$.

Examples/Illustrations **:** Let $T: R^{2\to} R^{3}$ be defined by $T(x, y) = (x + y, x - y, y)$.

Then the range space of $T = \{\beta \in R^{3} : T(\alpha) = \beta\ \forall\ \alpha \in R^{2}\}$ and the null space of $T = \{(0, 0)\}$.

Additional Inputs **:** -

Teaching Aids used **:** Black Board

References cited **:**

1. A text book of Mathematics of B.Sc Mathematics, Vol III, Linear Algebra by V.Venkateswara Rao & Others, published by S.Chand & Company, New Delhi.
2. Linear Algebra by J.N.Sharma and A.R.Vashista, published by Krishna Prakashan Mandir, Meerut.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-3

Any other activity **:** Group discussion

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Linear Algebra **Class : II year IV Sem**

Name of the Topic **:** Matrices

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to

(i) convert the given matrix into echelon form and normal form

(ii) Solve the system of linear equations in matrix form

Previous Knowledge to be reminded **:** Matrices and basic definitions learnt in their intermediate

Topic Synopsis **:**

- Echelon form: A matrix is said to be in echelon form if
  - (i) Zero rows, if any should be below the non-zero rows
  - (ii) The first non-zero element in any non-zero row should be unity
  - (iii) The number of zeroes before the first non-zero in any non-zero two is less than the number of such zeroes in the next row.
- The number of non-zero rows in the echelon form of a matrix is the rank of the matrix.
- The system of m linear equations in n unknowns can be written in matrix form as $AX = B$. The system $AX = B$ is consistent if $\rho(A) = \rho(A|B)$
  - (i) If $\rho(A) = \rho(B) = r <$number of variables, then the system is consistent and has infinite solutions
  - (ii) If $\rho(A) = \rho(B) = n$, the number of variables, then the system is consistent and has unique solution

(iii) If $\rho \neq \rho(A|B)$, then the system has no solution.

- A scalar λ is said to be an eigen value of a square matrix A corresponding to the eigen vector $X(\neq 0)$, if $AX = \lambda X$.
- Cayley-Hamilton theorem: Every square matrix satisfies its own characteristic equation

Examples/Illustrations **:** For the matrix $A = [1\ 2\ 3\ 2\ \ -1\ 4\ 3\ 1\ \ -1\ ]$, by Cayley Hamilton theorem, we have $A^3 + A^2 - 18A - 40I = O$.

Additional Inputs **:** Properties of eigen values and eigen vectors

Teaching Aids used **:** Black Board

References cited **:**

1. A text book of Mathematics of B.Sc Mathematics, Vol III, Linear Algebra by V.Venkateswara Rao & Others, published by S.Chand & Company, New Delhi.
2. Linear Algebra by J.N.Sharma and A.R.Vashista, published by Krishna Prakashan Mandir, Meerut.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-4

Any other activity **:** Seminar

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Linear Algebra **Class : II year IV Sem**

Name of the Topic **:** Inner Product Spaces

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to

(i) Know if a given vector space is an inner product space or not

(ii) Know the inequalities like triangle inequality, etc

Previous Knowledge to be reminded **:** Complex numbers

Topic Synopsis **:**

- Inner Product space: Let $V(F)$ be a vector space where F is the field of real numbers or the field of complex numbers. The vector space $V(F)$ is said to be an inner product space if there is defined for any two vectors $\alpha, \beta \in V$ an element $< \alpha, \beta > \in F$ such that

(i) $< \alpha, \beta > = \overline{< \beta, \alpha >}$ (conjugate symmetry)

(ii) $< \alpha, \alpha > \ > 0 \ \forall \ \alpha \neq \bar{0}$ (positivity)

(iii) $< a\alpha + b\beta, \gamma > = a < \alpha, \gamma > + \ b < \alpha, \gamma > \ \forall \ \alpha, \beta, \gamma \in V$ and $a, b \in F$ (Distributivity)

- Cauchy Schwarz's inequality: $|< \alpha, \beta >| \leq ||\alpha|| \, ||\beta|| \ \forall \ \alpha, \ \beta \in V$

- Triangle ineuality : $||\alpha + \beta|| \leq ||\alpha|| + ||\beta|| \ \forall \ \alpha, \ \beta \in V$

- Parallelogram law: $||\alpha - \beta||^2 + ||\alpha + \beta||^2 = 2(||\alpha||^2 + ||\beta||^2)$

- Let $V(F)$ be an inner product space and $\alpha, \ \beta \in V$. α is said to be orthogonal to β if $< \alpha, \beta > = 0$.

- Let S be a non-empty subset of an inner product space $V(F)$. The set S is said to be orthonormal set if $||\alpha_i|| = 1 \ \forall \ \alpha_i \in S$ and $< \alpha_i, \alpha_j > = 0 \ \forall \ \alpha_i, \alpha_j \in S$.

- Bessel's inequality: If $S = \{\alpha_1, \alpha_2, ..., \alpha_m\}$ is a finite orthonormal set in an inner product space V and $\beta \in V$ then $\sum_{i=1}^{m} \left|(\beta, \alpha_i)\right|^2 \leq ||\beta||^2$

- Parsvel's Identity: : If $S = \{\alpha_1, \alpha_2, ..., \alpha_m\}$ is a finite orthonormal set in an inner product space V and $\beta, \gamma \in V$ then $(\beta, \gamma) = \sum_{i=1}^{m} (\beta, \alpha_i)(\alpha_i, \gamma)$

**Examples/Illustrations : ** The set $\left\{\left(\frac{1}{3}, \frac{-2}{3}, \frac{-2}{3}\right), \left(\frac{2}{3}, \frac{-1}{3}, \frac{2}{3}\right), \left(\frac{2}{3}, \frac{2}{3}, \frac{-1}{3}\right)\right\}$ is an orthonormal set in R^3 with standard inner product.

Additional Inputs : -

Teaching Aids used : Black Board, LMS videos

References cited :

1. A text book of Mathematics of B.Sc Mathematics, Vol III, Linear Algebra by V.Venkateswara Rao & Others, published by S.Chand & Company, New Delhi.
2. Linear Algebra by J.N.Sharma and A.R.Vashista, published by Krishna Prakashan Mandir, Meerut.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-5

Any other activity : Slip test

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Real Analysis **Class : II year IV Sem**

Name of the Topic : Real Numbers

Hours required : 12 Hrs

Learning Objectives : Students will be able to check

(i) If the given sequence is convergent or divergent
(ii) If the given sequence is monotone or not

Previous Knowledge to be reminded : Real Number system, Limits

Topic Synopsis :

- A function $s: Z^{+} \rightarrow R$ is called a sequence of real numbers or a sequence.
- A sequence $\{s_n\}$ is said to be bounded if there exist $k_1, k_2 \in R$ such that $k_1 \leq s_n \leq k_2$ for all $n \in N$.
- A sequence $\{s_n\}$ is said to be convergent, if there exists $l \in R$ such that for each $\in > 0$, there exists a positive integer $m \ni |s_n - l| < \in \forall\, n \geq m$.
- Sandwich Theorem: If $\{s_n\}, \{t_n\}, \{u_n\}$ are three sequences such that for some positive integer k, $s_n \leq u_n \leq t_n\ \forall n \in N,\ n \geq k$ and $s_n = t_n = l$, then $u_n = l$.
- A sequence is said to be increasing if $s_1 \leq s_2 \leq \ldots \leq s_n \leq \ldots$
- A sequence is said to be decreasing if $s_1 \geq s_2 \geq \ldots \geq s_n \geq \ldots$
- A sequence which is either increasing or decreasing is called Monotone sequence.
- A monotone sequence is convergent iff it is bounded.
- Cauchy sequence: A sequence $\{s_n\}$ is called a Cauchy sequence if, for each $\in > 0$ $\exists\, m \in Z^{+} \ni |s_p - s_q| < \in \forall\, p, q \geq m$.

- Every convergent sequence is a Cauchy sequence.
- A sequence is convergent iff it is convergent.

Examples/Illustrations : The sequence $s_n = 1 + \frac{1}{2} + \frac{1}{2^2} + \ldots + \frac{1}{2^{n-1}}$ is monotone.

Additional Inputs :

Teaching Aids used : Black Board

References cited :

1. A text book of B.Sc Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-1

Any other activity : Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Real Analysis **Class : II year IV Sem**

Name of the Topic : Infinite series and tests of convergence

Hours required : 12 Hrs

Learning Objectives : Students will able to apply the appropriate

convergent tests for series to see if the given series is convergent or not.

Previous Knowledge to be reminded : Sequences and their limits

Topic Synopsis :

Def: Let $\sum_{n=1}^{\infty} u_n$ be a series of real numbers with partial sums $s_n = u_1 + u_2 + \dots + u_n,\ n \in Z^+$. If the sequence $\{s_n\}$ converges to s, we say that the series $\sum_{n=1}^{\infty} u_n$ converges to s. The number s is called the sum of the series and we write $\sum_{n=1}^{\infty} u_n = s$. If the sequence $\{s_n\}$ diverges, we say that the series diverges.

p-test: The series $\sum \frac{1}{n^p} = \frac{1}{1^p} + \frac{1}{2^p} + \frac{1}{3^p} + \dots,\ p \in R$ is convergent if $p > 1$ and divergent if $p \leq 1$

.

Comparision test: If $\sum u_n$ and $\sum v_n$ are two series of positive terms and $\frac{u_n}{v_n} = l \neq 0$, then the series $\sum u_n$ and $\sum v_n$ both converge or diverge together.

Root test: If $\sum u_n$ is a series of positive terms such that $u_n^{\frac{1}{n}} = l$, then

(a) $\sum u_n$ converges if $l < 1$ (b) $\sum u_n$ diverges if $l > 1$ and

(b) the test fails if $l = 1$.

Ratio test: If $\sum u_n$ is a series of positive terms such that $\frac{u_{n+1}}{u_n} = l$, then

(a) $\sum u_n$ converges if $l < 1$ (b) $\sum u_n$ diverges if $l > 1$ and

(b) the test fails if $l = 1$.

Leibnitz's Test: If $\sum u_n$ is a decreasing sequence of positive terms such that $u_n = 0$, then the alternating series $\sum_{n=1}^{\infty} (-1)^{n-1} u_n$ converges.

Examples/Illustrations : The series $\sum \frac{1}{\sqrt{n}}$ is not convergent by p-test.

Additional Inputs :

Teaching Aids used : Black Board

References cited :

1. A text book of B.Sc Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-2

Any other activity : Slip test on methods

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Real Analysis **Class : II year IV Sem**

Name of the Topic : Continuity

Hours required : 12 Hrs

Learning Objectives : Students will be able to

(i) check if a given function is continuous or not
(ii) understand the types of discontinuities
(iii) understand the difference between continuity and uniform continuity

Previous Knowledge to be reminded : Limits of functions

Topic Synopsis :

Def: Let $f: S \to R$ be a function and $a \in S$. Then we say that 'f tends to limit $l \in R$' as 'x tends to a' if for each $\in > 0 \ \exists \ \delta > 0 \ \ni x \in S$ and $0 < |x - a| < \delta$ implies $|f(x) - l| < \in$. We write as $f(x) \to l$ as $x \to a$ or $f(x) = l$.

Def: Let $f: S \to R$ be a function and $a \in S$. f is said to be continuous at a if for every $\in > 0 \ \exists \ \delta > 0 \ \ni x \in S$ and $0 < |x - a| < \delta$ implies $|f(x) - f(a)| < \in$.

Def: A function $f: S \to R$ is said to be continuous on the domain S, if it is continuous at every point of S.

If f is not continuous at $a \in S$, then we say f is discontinuous at $a \in S$. The types of discontinuity are removable discontinuity, jump discontinuity or discontinuity of second kind.

If f is continuous on $[a, b]$, then f is bounded on $[a, b]$ and attains its bounds.

Def: Let $f: S \to R$ be a function. We say that f is uniformly continuous on S if given $\in > 0 \ \exists \ \delta > 0 \ \ni x \in S$ and $0 < |x_1 - x_2| < \delta$ implies $|f(x_1) - f(x_2)| < \in$.

If $f: S \to R$ is uniformly continuous, then f is continuous in S.

Examples/Illustrations : If $f: R \to R$ and $f(x) = \{\frac{e^{\frac{1}{x}} - e^{\frac{-1}{x}}}{e^{\frac{1}{x}} + e^{\frac{-1}{x}}}, \ x \neq 0 \ 0 \qquad x = 0$

Then LHL=-1 and RHL=1 and hence $f(x)$ is discontinuous of first kind at $x = 0$.

Additional Inputs :

Teaching Aids used : Black Board

References cited :

1. A text book of B.Sc Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-3

Any other activity :

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Real Analysis **Class : II year IV Sem**

Name of the Topic : Differentiation and Mean Value Theorems

Hours required : 12 Hrs

Learning Objectives : Students will

(i) check if a given function is differentiable or not at a point

(ii) prove the mean value theorems and apply them to prove some standard inequalities

Previous Knowledge to be reminded : Limits and continuity

Topic Synopsis :

Def: : Let $f: S \to R$ be a function. Let $c \in S$ andl$a \in R$. f is said to be derivable at c if for every

$\in\ >\ 0 \ \exists\ \delta\ >\ 0\ \exists x \in S$ and $0\ <|x\ -\ c|<\ \delta$ implies $\left|\frac{(f(x)-f(c))}{(x-c)}\right| <\ \in$.

Rolle's Theorem: If a function $f: [a, b] \to R$ is such that

(i) f is continuous on $[a, b]$

(ii) f is derivable on (a, b) and

(iii) $f(a) =\ f(b)$

Then $\exists$ atleast one point $\in\ (a, b) \ni f^{'}(c) =\ 0$.

Lagrange's Theorem: If a function $f: [a, b] \to R$ is such that

(i) f is continuous on $[a, b]$

(ii) f is derivable on (a, b)

Then $\exists$ atleast one point $\in\ (a, b) \ni f^{'}(c) = \frac{f(b)-f(a)}{b-a}$.

Lagrange's Theorem: If $f: [a, b] \to R$, $g: [a, b] \to R$ are such that

(i) f, g are continuous on $[a, b]$ (ii) f, g are derivable on (a, b)

(iii) $g^{'}(x) \neq 0$ for all $c \in (a, b)$

Then ∃ atleast one point ∈(a, b) such that $\frac{f(b)-f(a)}{g(b)-g(a)} = \frac{f'(c)}{g'(c)}$.

Examples/Illustrations **:** $f(x) = |x - 1| + |x - 2|$ is continuous but not differentiable at $x = 1, 2$.

Additional Inputs **:**

Teaching Aids used **:** Black Board

References cited **:**

1. A text book of B.Sc Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-4

Any other activity **:** Seminar

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Real Analysis **Class : II year IV Sem**

Name of the Topic **:** Riemann Integration

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to find the integral via darboux sums and prove the fundamental theorem of integral calculus.

Previous Knowledge to be reminded **:** Limits, Continuity and Differentiability

Topic Synopsis **:**

- Riemann Integral: Let $f\colon [a,b]\to R$ be a bounded function and P be a partition of $[a,b]$. If $\underline{\int_a^b} f(x)dx = Sup\{L(P,f)\colon P\in\emptyset[a,b]\} = Inf\{U(P,f)\colon P\in\emptyset[a,b]\} = \overline{\int_a^b} f(x)dx$, then we say that f is Riemann integral over $[a,b]$ and denoted as $\int_a^b f(x)dx$.
- Some classes of bounded integrable functions: A function $f\colon [a,b]\to R$ is integrable on [a,b] if

(i) f is continuous on $[a,b]$

(ii) f is monotone on $[a,b]$

(iii) f is bounded with finite number of discontinuity points

(iv) f is bounded and the set of discontinuity points has a finite number of limit points.

- Fundamental theorem of Integral calculus: If $f\colon [a,b]\to R$ and $f\in R[a,b]$ and $\emptyset$ is a primitive of f, then $\int_a^b f(x)dx = \emptyset(b) - \emptyset(a)$.

Examples/Illustrations : If $f\colon [a, b] \rightarrow R$ is continuous or monotonic on $[a, b]$, then f is integrable on $[a, b]$.

Additional Inputs :

Teaching Aids used : Black Board

References cited :

1. A text book of B.Sc Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-5

Any other activity : Unit test

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Multiple Integrals and Applications of Vector Calculus Class : III year V Sem

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Name of the Topic **:** Multiple Integrals- I

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to solve Differential equations with constant coefficients and variable coefficients using Laplace Transforms.

Previous Knowledge to be reminded **:** Partial Fractions

Topic Synopsis **:**

Examples/Illustrations **:**

Additional Inputs :

Teaching Aids used :

References cited :

1. A text book of mathematics, Integral Transforms, Dr.A.Anjaneyulu, Deepthi Publications, Tenali.
2. A course of Mathematical Analysis by Shanthi Narayana and P.K. Mittal, Published by S.Chand and Company pvt Ltd. Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class :

Any other activity :

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Multiple Integrals and Applications of Vector Calculus **Class : III year V Sem**

Name of the Topic **:** Multiple Integrals- II

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to solve Differential equations with constant coefficients and variable coefficients using Laplace Transforms.

Previous Knowledge to be reminded **:** Partial Fractions

Topic Synopsis **:**

Examples/Illustrations **:**

Additional Inputs :

Teaching Aids used :

References cited :

1. A text book of mathematics, Integral Transforms, Dr.A.Anjaneyulu, Deepthi Publications, Tenali.
2. A course of Mathematical Analysis by Shanthi Narayana and P.K. Mittal, Published by S.Chand and Company pvt Ltd. Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class :

Any other activity :

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Ring Theory and Vector Calculus **Class : III year V Sem**

Name of the Topic **:** Vector Differentiation

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to find the Gradient of a scalar point functions, divergence and curl of a vector point function.

Previous Knowledge to be reminded **:** Differentiation formulae, dot product and cross product.

Topic Synopsis **:**

- The necessary and sufficient condition that $f(t)$ is a vector of constant magnitude is $f\cdot\frac{df}{dt} = 0$.
- The necessary and sufficient condition that $f(t)$ is a vector of constant direction is $f\times\frac{df}{dt} = 0$.
- Gradient of a scalar point function: Let φ be a scalar point function having the directional derivatives $\frac{\partial\varphi}{\partial x}, \frac{\partial\varphi}{\partial y}, \frac{\partial\varphi}{\partial z}$ in the directions of i, j, k respectively. Then the vector function $i\frac{\partial\varphi}{\partial x} + j\frac{\partial\varphi}{\partial y} + k\frac{\partial\varphi}{\partial z}$ is called the gradient of φ is denoted by $grad\varphi$ or $\nabla\varphi$.
- Divergence of a vector: Let f be any continuously differentiable vector point function. Then divergence of f is denoted by $divf$ and is given by $divf = \nabla\cdot f = \left(i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}\right)\cdot f$
- Curl of a vector: Let f be any continuously differentiable vector point function. Then Curl of f is denoted by $Curlf$ and is given by $Curlf = \nabla\times f = \left(i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}\right)\times f$
- $\nabla r = \frac{r}{r}$; $\nabla\left(\frac{1}{r}\right) = -\frac{r}{r^3}$; $\nabla f(r) = f'(r)\frac{r}{r}$
- $grad\, r^m = mr^{m-2}r$ $grad(r.a) = a$
- $div\, r = 3$ $div(r\times a) = 0$
- $curl\, r = 0$ $curl(r\times a) = -2a$
- $grad(A.B) = (B.\nabla)A + (A.\nabla)B + B\times(curlA) + A\times(curlB)$

- $div(A \times B) = B.(curlA) - A.(curlB)$
- $curl(A \times B) = A(divB) - B(divA) + (B.\nabla)A - (A.\nabla)B$

Examples/Illustrations **:** If $\bar{r} = acost\, i + asint\, j + at\, tan\theta\, k$ then

$$\frac{d\bar{r}}{dt} = -asint\, i + acost\, j + atan\theta\, k$$

Additional Inputs **:** -

Teaching Aids used **:** Black Board

References cited **:**

1. A text book of B.Sc., Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-3

Any other activity **:** Group discussion

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Ring Theory and Vector Calculus **Class : III year V Sem**

Name of the Topic : Vector Integration

Hours required : 12 Hrs

Learning Objectives : Students will be able to calculate the line integral, surface integral and volume integral.

Previous Knowledge to be reminded : Integration and differentiation formulae

Topic Synopsis :

- Line integral: Let $F(r)$ be a vector point function defined and continuous along a sommth curve C. Then the line integral in cartesian form is

$$\oint_C F.dr = \oint_C \left(F_1 \frac{dx}{dt} + F_2 \frac{dy}{dt} + F_3 \frac{dz}{dt}\right) dt$$

- Surface integral: Let $F(r)$ be a continuous vector point function defined over the smooth surface $r = f(u, v)$. Let S be a region of the surface. The surface integral is

$$\int_S F(r) \cdot dA = \int_S F \cdot N dS$$

If R is the projection of S on $xy - plane$ then $\int_S F \cdot NdS = \iint_R F.N \frac{dxdy}{|N.k|}$

Similarly, we have $\int_S F \cdot NdS = \iint_R F.N \frac{dydz}{|N.i|}$ and $\int_S F \cdot NdS = \iint_R F.N \frac{dxdz}{|N.j|}$

- Volume integral: Let V be a volume bounded by a surface $r = f(u, v)$. $F(r)$ be a vector point function defined over V. Then

$$\int_V F(r)dV = \iiint (F_1 i + F_2 j + F_3 k)dxdydz.$$

Examples/Illustrations **:** If $F = 3x^2 i + (2xz - y)j + zk$ then $\int_C F.dr$ along the straight line C from $(0, 0, 0)$ to $(2, 1, 3)$ is 16.

Additional Inputs **:** Discussing Objective type questions

Teaching Aids used **:** Black Board

References cited **:**

1. A text book of B.Sc., Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching **:**

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class **:** Assignment-4

Any other activity **:** Seminar

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Ring Theory and Vector Calculus **Class : III year V Sem**

Name of the Topic : Vector Integration Applications

Hours required : 12 Hrs

Learning Objectives : Students will be able to

(i) Convert the volume integral to surface integral and vice-versa
(ii) Convert the line integral to surface integral and vice-versa
(iii) Convert the line integral to surface integral

Previous Knowledge to be reminded : Line, Surface and Volume integrals

Topic Synopsis :

- Gauss Divergence Theorem: Let S be a closed surface enclosed a volume V. If F is continuously differentiable vector point function, then $\int_V divF\, dV = \int_S F.NdS$ where N is the outward drawn unit normal vector at any point of S.

- Green's Theorem in a plane: Let S be a closed region in $xy - plane$ enclosed by a curve C. Let P and Q be continuous and differentiable scalar functions of x and y in S. Then $\oint_C Pdx + Qdy = \iint_S (\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y})dxdy$, the line integral being taken round C such that S is on the left as one advances along C.

- Stokes Theorem: Let S be a surface bounded by a closed, non-intersecting curve C. If F is any differentiable vector point function, then $\oint_C F.dr = \int_S CurlF.NdS$ where C is traversed in the positive direction. The direction of C is called positive if a person, walking on the boundary of S in this direction, with his head pointing in the direction of outward drawn normal N to S, has the surface on his left.

**Examples/Illustrations : ** Examples converting line integral to surface integral and surface integral to volume integrals and vice-versa.

Additional Inputs : Discussing Objective type questions

Teaching Aids used : Black Board

References cited :

1. A text book of B.Sc., Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-5

Any other activity : Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Abstract Algebra **Class : II year III Sem**

Name of the Topic **:** Groups

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to

(i) Understand the structure of a group and the properties involved in it
(ii) find the order of each element in a finite group

Previous Knowledge to be reminded **:** Axioms or laws of a set i.e., closure law, associative law, commutative law, etc.

Topic Synopsis **:**

- Group: If G is a non-empty set and o is a binary operation defined on G such that the following laws are satisfied, then (G, o) is a group.
  G_1(Associative law): $(aob)oc = ao(boc) \ \forall\ a, b, c \in G$

  G_2(Identity axiom): $\exists\ e \in G\ \ni aoe = a = eoa\ \forall\ a \in G$

  G_3(Inverse axiom): For each $a \in G$, $\exists\ b \in G \ni aob = e = boa$
- In addition, if G_4 is also satisfied, the (G, o) is called an abelian group.

  G_4(Commutative law): $aob = boa\ \forall\ a, b \in G$.
- Order of a group: The number of elements in a group G is called its order and is denoted by $O(G)$.
- If the number of elements in a group are finite, then the group is called finite group. If the number of elements are infinite, then the group is called infinite group. For an infinite group, the order is either 0 or infinite.
- In a group, Identity element is unique and inverse of each element is unique.
- If G is a group and $a, b \in G$, then the equations $ax = b$ and $ya = b$ have unique solutions in G.
- A finite semi-group satisfying cancellations laws is a group.
- All groups of order 4 and less are commutative.

- If every element of a group G is its own inverse, then G is abelian.
- A finite semigroup satisfying cancellation laws is a group.

Examples/Illustrations :

- $(Z_n, +)$ is an abelian group and $(Z_n, \times)$ is a commutative semigroup with identity.
- n^{th} roots of unity forms an abelian group with respect to multiplication.
- The set of all 2×2 matrices form a group w.r.t matrix multiplication.

Additional Inputs : Dihedral group

Teaching Aids used : Black Board, LMS Videos

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.
2. Abstract Algebra by J.B.Fraleigh, published by Narosa publishing house.

Student Activity planned after teaching:

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-1

Any other activity : Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Abstract Algebra **Class : II year III Sem**

Name of the Topic : Subgroups and Cosets

Hours required : 12 Hrs

Learning Objectives : Students will be able to

(i) Know the necessary and sufficient condition for a non-empty subset to be a subgroup
(ii) find the distinct cosets of a given subgroup of a group and could see if a given positive integer forms the order of a subgroup of a given group.

Previous Knowledge to be reminded : Groups and their properties

Topic Synopsis :

- Subgroup: Let $(G, .)$ be a group. Let H be a non-empty subset of G such that $(H, .)$ is a group. Then H is called a subgroup of G.

- If H is any subgroup of a group G, then $HH = H$ and $H^{-1} = H$.
- A non-empty complex H of a group G is a subgroup of G if and only if

$$a, b\in H \Rightarrow ab^{-1}\in H$$

- A finite non-empty complex H of a group G is a subgroup of G if and only if

$$a, b\in H \Rightarrow ab\in H$$

- Let H_1, H_2 be two subgroups of a group G. Then $H_1 \cap H_2$ is also a subgroup of G. But $H_1 \cup H_2$ is subgroup of G if and only if one is contained in the other.
- Coset : Let $(H,.)$ be a subgroup of the group $(G, .)$ and $a\in G$. Then the set $aH = \{ah/h\in H\}$ is called a left coset of H in G generated by a and the set $Ha = \{ha/h\in H\}$ is called a right coset of H in G generated by a.
- Any two left(right) cosets of a subgroup are either disjoint or identical.
- Let H be a subgroup of a group G and $a, b\in G$. Then
  i. $Ha = Hb \Leftrightarrow ab^{-1}\in H$
  ii. $aH = bH \Leftrightarrow a^{-1}b\in H$

- Lagrange's Theorem: The order of a subgroup of a finite group divides the order of a group.
- Converse of a Lagrange's theorem is not true.

Examples/Illustrations :

- $(\{1, -1\},.)$ is a subgroup of $(\{1, -1, i, -i\}, .)$
- The set $G = \left\{x: x = 2^a 3^b \ and\ a, b \in Z\right\}$ is a subgroup of R.

Additional Inputs : Discussing Objective type questions

Teaching Aids used : Black Board, LMS videos

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.
2. Abstract Algebra by J.B.Fraleigh, published by Narosa publishing house.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-2

Any other activity : Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Abstract Algebra **Class : II year III Sem**

Name of the Topic : Normal Subgroups, Homomorphisms

Hours required : 12 Hrs

Learning Objectives : Students will be able to know if a given subgroup is a normal subgroup or not.

Previous Knowledge to be reminded : Groups and subgroups with their properties.

Topic Synopsis :

- Normal subgroup: A subgroup H of a group G is said to be a normal subgroup of G if $\forall\ x \in G$ and $h \in H,\ xhx^{-1} \in H$. We denote $N \triangleleft G$.
- A subgroup H of a group G is normal, if $xHx^{-1} = H\ \forall\ x \in G$.
- Every subgroup of an abelian group is normal.
- The intersection of any two normal subgroups of a group is also a normal subgroup.
- Let G be a group. Then $Z(G) = \{a \in G : ax = xa\ \ \forall\ x \in G\}$ is called centre or normalizer of the group G.
- Centre of G is a normal subgroup of G.
- Quotient group: Let H is a normal subgroup of G. The set $\frac{G}{H}$ of all cosets of H in G w.r.t the coset multiplication is a group called Quotient group or Factor group.
- Every quotient group of an abelian group is abelian.
- Simple group: A group G is called simple if it has no proper normal subgroups.
- If H is a normal subgroup of a finite group G, then $O\left(\frac{G}{H}\right) = \frac{O(G)}{O(H)}$

- Homomorphism: Let G, G' be two groups and f is a mapping from G into G'. Then f is said to be a homomorphism from G into G' if
  $$f(a.b) = f(a).f(b)\ \forall\ a, b \in G.$$
- If f is onto, then f is called epimorphism. If f is one-one, then it is called monomorphism. A homomorphism of a group into itself is an endomorphism.
- A one-one onto homomorphism from G into G' is called an isomorphism. An isomorphism from G to itself is an automorphism.
- The homomorphic image of a group is a group.
- The homomorphic image of an abelian group is abelian.
- Kernel of a homomorphism: If f is a homomorphism of a group G into a group G', then the set $K = \{x \in \frac{G}{f(x)} = e'\}$ is called Kernel of f.
- If f is a homomorphism of a group G into a group G', then the Kernel of f is a normal subgroup of G.
- Fundamental theorem on homomorphism of groups: Every homomorphic image of a group G is isomorphic ot some quotient group of G.
- Inner automorphism: Let G be a group and $a \in G$. The function $f_a : G \to G$ defined by $f_a(x) = a^{-1}xa$ for all $x \in G$ is an automorphism on G. This automorphism is called an inner automorphism of G.

Examples/Illustrations : $H = \{1, -1\}$ is a normal subgroup of the group of non-zero real numbers under multiplication.

- Let $(G = Z, +)$ and $(G' = Z_m, +_m)$. Then $f: G \to G'$ defined by $f(a) = a'\ \forall\ a \in G$ is a homomorphism.
- $\left(Z_n, +_n\right)$ is an homomorphic image of $(Z, +)$.

Additional Inputs : Discussing Objective type questions

Teaching Aids used : Black Board, LMS Videos

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.
2. Abstract Algebra by J.B.Fraleigh, published by Narosa publishing house.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-3

Any other activity : Group discussion

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Abstract Algebra **Class : II year III Sem**

Name of the Topic **:** Permutations and Cyclic groups

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to understand

(i) Symmetric group and its properties

(ii) Cyclic group and its properties

Previous Knowledge to be reminded **:** Bijective mappings

Topic Synopsis **:**

- Permutation: A permutation is a one-one mapping of a non-empty set onto itself.
- The set of all permutations defined over a non-empty set S forms a group under the operation permutation multiplication and is called symmetric group S_n.
- A cycle of length 2 is called a transposition.
- Every permutation can be uniquely expressed as a product of disjoint cycles.
- Even and Odd permutations: A permutation is said to be even(odd) if it can be expressed as a product of even(odd) number of transpositions.
- Let S_n be a symmetric group. The set of all even permutations forms a group and is called an Alternating group. It is denoted by A_n.
- Cayley's theorem: Every finite group G is isomorphic to a permutation group.
- Cyclic group: Let G be a group. If ∃ an element $a \in G \ni G = \{a^n : n \in Z\}$, then G is said to be a cyclic group generated by an element a.
- Every cyclic group is abelian.
- Every subgroup of cyclic group is cyclic.
- Every finite group of prime order is cyclic.
- The order of a cyclic group is equal to the order of its generator.
- If G is an infinite cyclic group, then G has exactly two generators.
- Every cyclic group is isomorphic to Z or Z_n for some n.

Examples/Illustrations :

- $(\{1, -1, i, -i\}, .)$ is a cyclic group generated by i or $-i$.
- The number of generators of a cyclic group of order 15 are 8.

Additional Inputs : Discussing Objective type questions

Teaching Aids used : Black Board

References cited :

1. A text book of Mathematics for B.A/B.Sc Vol 1 by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.
2. Abstract Algebra by J.B.Fraleigh, published by Narosa publishing house.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-5

Any other activity : Quiz

Signature of the Lecturer

LESSON PLAN

Name of the Lecturer : Dr. Ch. Srimannarayana **Name of the Department : Mathematics**
Paper : Ring Theory **Class : II year III Sem**

Name of the Topic **:** Rings-I

Hours required **:** 12 Hrs

Learning Objectives **:** Students will be able to understand

(i) the structure of a ring
(ii) the definitions and properties of zero divisors, integral domain, field, subrings, ideal, etc.

Previous Knowledge to be reminded **:** Group theory basic properties

Topic Synopsis **:**

- Ring: Let R be a non-empty set and $+, \cdot$ be two binary operations on R. Then $(R, +, \cdot)$ is said to be a ring if
  - (i) $(R, +)$ is a commutative group
  - (ii) $(R, \cdot)$ is a semi-group
  - (iii) Distributive laws hold
- Integral domain: A ring R is said to be an integral domain if it is commutative and has no zero divisors.
- Division ring: A ring with atleast two elements is called a division ring if R has a unity element and every non-zero element is invertible under multiplication.
- Field: A commutative division ring is called a Field.
- A Division ring and a Field has no zero divisors.
- Every Field is an Integral Domain.
- Every finite Integral Domain is a field.
- Boolean ring: A ring R is said to be a Boolean ring if $a^2 = a$ for all $a \in R$.
- Characteristic of a ring: Let R be a ring. If there exists a least positive integer n such that $na = 0$ for all $a \in R$, then n is called the characteristic of R. If there is no such positive integer, then the characteristic of R is said to be zero or infinite.
- The characteristic of a Boolean ring is 2. The characteristic of an integral domain is either 0 or a prime number.
- Subring: Let $(R, +, \cdot)$ be a ring and S be a non-empty subset of R. $(S, +, \cdot)$ is a subring of $(R, +, \cdot)$ if $(S, +, \cdot)$ is also a ring w.r.t the same binary operations as in R.
- Ideal: Let $(R, +, \cdot)$ be a ring. A non-empty subset U of R is called an ideal of R if

(i) $a, b \in U \Rightarrow a - b \in U$

(ii) $a \in U,\ r \in R \Rightarrow ar, ra \in U$

- The only ideals of a field F are $\{0\}$ and F.

Examples/Illustrations :

- $(Z_m, +_m, \times_m)$ is a ring where $Z_m = \{0, 1, 2, \ldots, m - 1\}$
- Let R be the ring of all 2×2 matrices over Z w.r.t matrix addition and matrix multiplication. Then
   - **i.** $A = \{(a\ 0\ b\ 0): a, b \in Z\}$ is a left ideal of R, but not right ideal of R.
   - **ii.** $A = \{(a\ b\ 0\ 0): a, b \in Z\}$ is a right ideal of R, but not left ideal of R.

Additional Inputs : Euclidean rings

Teaching Aids used : Black Board, LMS videos

References cited :

1. A text book of B.Sc., Mathematics by B.V.S.S.SARMA & Others, published by S.Chand & Company, New Delhi.
2. Abstract Algebra by J.B.Fraleigh, published by Narosa publishing house.

Student Activity planned after teaching :

- Formative and summative evaluation
- Problem solving sessions

Activity planned outside the Class : Assignment-1

Any other activity : Quiz

Signature of the Lecturer