APPLIED MECHANICS (Statics)

Course Code: CE 101

Lecturer: 4
Tutorial: 2
Practical: 0

Year: I
Part: II
Course Credit: 4

Course Objectives:

This course will help you analyze the effects of different types of forces on particles and rigid bodies at rest and in motion. It also provides concepts and knowledge of engineering applications and helps in understanding civil engineering in later courses by applying the fundamentals of mechanics in engineering fields.

	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	100
Cr	4	2	0	40	0	60	0	

Unit 1 Basic Concept of Mechanics and Static Equilibrium (5 hours)

1.1 Definitions, Type and Scope of Mechanics

1.2 Fundamental Concepts and Principles of Engineering Mechanics

1.3 Concept of Particle, Rigid and Deformable Bodies

1.4 Equilibrium, Equation of Equilibrium in 2D and 3D Analysis of Particle and Rigid Body

1.5 Concept of Free Body Diagram with Examples

Unit 2 Forces Acting on Particle and Rigid Body (9 hours)

2.1 Different Types of Forces: Internal/External Force, Adhesive/ Cohesive Force, Point/ Line/ Surface Force and Contact Body Force

2.2 Resolution and Composition of Forces

2.3 Principle of Transmissibility and Equivalent Forces

2.4 Varignon's Theorem and it's Application

2.5 Moments of a Force About a Point and About an Axis

2.6 Definition, Types and Characteristics of Couple, Resolution of a Force into a Force and a Couple

2.7 Resultant of Force and Moment for a System: Coplanar, Concurrent and General Force System

2.8 Concept and Formation of Wrench (Force and Couple Lying on a Single Plane)

Unit 3 Friction (4 hours)

3.1 Definition, Types and Application of Friction, Laws of Friction, Static and Dynamic Coefficient of Friction, Angle of Friction

3.2 Sliding and Overturning Condition of a Body

3.3 Concept and Working Principle of Jackscrew

3.4 Dry Friction (Ladder and Wedge Friction)

Unit 4 Analysis of Simple Beams and Frames (10 hours)

4.1 Definition of Structure and its types

4.2 Various Types of Load/Force on the Structure

4.3 Various Types of Supports; Reactions and Degree of Freedom

4.4 Internal and External Forces in the Structure

4.5 Relationship Between Load, Shear Force and Bending Moment

4.6 Statically and Geometrically Stable/ Unstable Beams and Frames

4.7 Statically Determinate and Indeterminate Beams and Frames, Degree of Static Indeterminacy

4.8 Axial Force, Shear Force and Bending Moment Diagrams for Determinate Beams and Frames

Unit 5 Analysis of Plane Trusses (5 hours)

5.1 Definition of Truss, Assumption of Ideal Truss, Types and Uses of Truss

5.2 Statically and Geometrically Stable and Unstable Truss

5.3 Statically Determinate and Indeterminate Truss, Degree of Static Indeterminacy

5.4 Analysis of Truss by the Method of Joint and Section

Unit 6 Centre of Gravity, Centroid, Moment of Inertia, and Mass Moment of Inertia (5 hours)

6.1 Concepts of Centre of Gravity and Centroid of Line, Area and Volume

6.2 Second Moment of Area/Moment of Inertia and Radius of Gyration

6.3 Perpendicular and Parallel Axis Theorem for Moment of Inertia

6.4 Concept of Mass Moment of Inertia

Unit 7 Kinematics of Particles (Rectilinear and Curvilinear Motion) (7 hours)

7.1 Position, Velocity and Acceleration of a Particle for Rectilinear Motion

7.2 Dependent and Relative Motion of Particles

7.3 Position, Velocity and Acceleration of a Particle for Curvilinear Motion

7.4 Projectile Motion, Tangential and Normal Components of Velocity and Acceleration

7.5 Radial and Transverse Components of Velocity and Acceleration

Unit 8 Kinetics of Particles: Force, Acceleration, Energy and Momentum (8 hours)

8.1 Newton's Second Law of Motion, Linear Momentum and Impulsive Motion

8.2 Dynamic Equilibrium and Equation of Motion

8.3 Angular Momentum and Rate of Change of Angular Momentum

8.4 Equation of Motion for Rectilinear and Curvilinear Motion (Rectangular Components, Tangential & Normal Components and Radial & Transverse Components) of Particle

8.5 Work and Energy Principle, Principle of Conservation of Energy, Concept of Conservative and Non- Conservative System

8.6 Definition and Types of Impact

Unit 9 Kinematics and Kinetics of Rigid Body in Plane Motion, Energy and Momentum Methods (7 hours)

9.1 Translation, Rotation and General Plane Motion

9.2 Absolute and Relative Velocity in Plane Motion

9.3 Instantaneous Centre of Rotation

9.4 Equation of Motion: D'Alembert's Principle

9.5 Angular Momentum of Rigid Body

9.6 Principle of Work and Energy for a Rigid Body

9.7 Kinetic Energy for a Rigid Body

Tutorials (30 hours)

There shall be related tutorials exercised in class and given as regular homework exercise. Tutorial can be as following for each specified chapters

1. Basic Concept of Mechanics and Static Equilibrium (2 hours)

2. Forces Acting on Particle and Rigid Body (3 hours)

3. Friction (2 hours)

4. Analysis of Simple Beams and Frames (6 hours)

5. Analysis of Plane Trusses (3 hours)

6. Centre of Gravity, Centroid, Moment of Inertia and Mass Moment of Inertia (5 hours)

7. Kinematics of Particles (Rectilinear and Curvilinear Motion) (3 hours)

8. Kinetics of Particles: Force, Acceleration, Energy and Momentum (3 hours)

9. Kinematics and Kinetics of Rigid Body in Plane Motion, Energy and Momentum Methods (3 hours)

Reference

1. Beer F.P. and E.R. Johntson "Vector Mechanics for Engineers", Tata McGraw Hill Publishing Co.Ltd.

2. R.C. Hibbler, Ashok Gupta, "Engineering Mechanics –Statics and Dynamics", New Delhi, Pearson,

3. I.C. Jong and B.G. Rogers, "Engineering Mechanics- Statics and Dynamics",

4. R. Suwal, "A Text Book of Applied Mechanics" Second Edition, Mark Line Publication

5. H.R. Parajuli and S. Neupane "Applied Mechanics for Engineers" M.K. Publishers and Distributors

6. H.R. Parajuli and S. Neupane "Applied Mechanics II (Dynamics) for Engineers" M.K. Publishers and Distributors

7. M.R. Dhital, "A Course Manual on Applied Mechanics I (Statics)", TU, IOE, CIMDU,

8. M.R. Dhital, "A Course Manual on Applied Mechanics II (Dynamics)", TU, IOE, CIMDU,

9. Shame, I.H., "Engineering Mechanics- Statics and Dynamics", Prentice Hall of India, New Delhi,

10. D.K. Anand and P.F. Cunnif, "Engineering Mechanics- Statics and Dynamics",

11. R.S. Khurmi, "A Text Book of Engineering Mechanics",

12. Egor. P. Popov "Engineering Mechanics of Solids", New Delhi, Prentice Hall of India.

Evaluation Schedule:

The final evaluation will have questions from all units. The marks distribution from different units shall be as follows:

Units	Unit Title	Scheduled Hours	Marks
Unit 1	Basic Concept of Mechanics and Static Equilibrium	5	5
Unit 2	Forces Acting on Particle and Rigid Body	9	9
Unit 3	Friction	4	4
Unit 4	Analysis of Simple Beams and Frames	10	10
Unit 5	Analysis of Plane Trusses	5	5
Unit 6	Centre of Gravity, Centroid, Moment of Inertia, and Mass Moment of Inertia	5	5
Unit 7	Kinematics of Particles (Rectilinear and Curvilinear Motion)	7	7
Unit 8	Kinetics of Particles: Force, Acceleration, Energy and Momentum	8	8
Unit 9	Kinematics and Kinetics of Rigid Body in Plane Motion, Energy and Momentum Methods	7	7
	Total	**60**	**60**

Note: The marks distribution shown in the table above might be subjected to minor changes.

RAJARSHI JANAK UNIVERSTIY
Faculty of Science, Technology & Engineering

Subject: Civil Engineering Materials
Level: Bachelor in Engineering
Year: I
Semester: II

Course Code: CE 102
Credit Hours: 2L+0Tu+1P
Lecture Hours: 45 Hours

Course Objectives:

Provides students with an introductory knowledge of a wide range of materials used in construction of civil engineering projects. The focus of this course is on the properties, defects, production, preservation, alternatives and utilization of different building materials, which will help you choose the right material for your civil engineering project in design as well as construction. This helps provide a basis for material selection, proper considerations, and precautions during planning, design and construction.

	Teaching Schedule Hours/Week			**Evaluation Scheme**				
				Internal Evaluation		**Final Evaluation**		**Total**
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	75
Cr	2	0	1	20	25	30	0	

Unit 1 Basics of Civil Engineering Materials (2 hours)

1.1 Materials of civil constructions: buildings; road and bridges; irrigation and hydropower; water supply and sewerage; gas and petroleum supply

1.2 Classification of materials: existence in nature, functions or usage; metallurgy; composition of materials

1.3 Properties: physical; chemical; mechanical; thermal; optical; electrical; magnetic

1.4 Failure of materials: ductile and brittle failure

1.5 Factors affecting selection of materials: properties and performance; attributes and suitability; strength, durability and safety; availability, reliability and disposability; and economy and environmental impact

1.6 Environment interactions of materials: corrosion; weathering; erosion; thermal strain; exposure to moisture, sunlight, and chemicals

Unit 2 Stones and aggregates (3 hours)

2.1 Classification of rocks and aggregates: geological, physical and chemical classifications of rocks; introduction to coarse and fine aggregates

2.2 Properties of stones and aggregates: physical, chemical and mechanical properties

2.3 Characteristics of good stones and aggregates: appearance; structure; strength; porosity and absorption; weathering; fire resistance; hardness and toughness; specific gravity; thermal properties

2.4 Selection and use of stones and aggregates: selection criteria; various uses of stones in engineering constructions

2.5 Deterioration and preservation of stones and aggregates: deterioration and its retardation; preservation and preservatives used in stones

2.6 Production, storage and handling of stones and aggregates: natural bed of stones; selection of quarry site; methods of quarrying; dressing of stones

Unit 3 Clay and Clay Products (3 hours)

3.1 Clay: use of clay in constructions; classification/types of clays; properties of clays

3.2 Brick earth: ingredients; properties and testing (consistency test; molding property test; deformation and shrinkage test on burning, strength and quality of brick test)

3.3 Bricks: use of bricks; manufacturing of bricks; classification and properties (physical and mechanical) of bricks (unburnt and burnt bricks); characteristics of good bricks; standard tests for bricks (shape and size test; color test; soundness test; hardness test; water adsorption test; efflorescence test; compressive strength test)

3.4 Tiles: use of tiles; manufacturing process of tiles; types and properties of tiles (roof tiles, wall tiles, floor tiles, drain tiles); characteristics of good tiles

3.5 Terracotta, earthenware and glazing: properties; use; composition; production

3.6 Storage and handling of clay and clay products

Unit 4 Lime and pozzolanic materials (2 hours)

4.1 Sources and constituent of limestones: limestones and stone lime; kankar lime; shell lime; magnesian lime; impurities in limestones

4.2 Classification/types of limes: quick lime; flat lime, hydraulic lime, poor lime; hydrated lime; milk lime; lump lime

4.3 Characteristics of lime, hydration of lime, slaking nature of lime, solidification of lime

4.4 Manufacture/production of lime: Flow diagram of lime production from limestone and kankar

4.5 Storage, handling and use of different types of lime

4.6 Types of pozzolanic materials: volcanic ash; calcinated clay products; clay/kaolin pozzolana; mineral slag; ashes of organic origin and uses

Unit 5 Cement (4 hours)

5.1 Fundamentals of cement: ingredients of cement; Cement clinkers; compounds of cement clinkers and their functions in cement type and properties of cement; storage, handling and use of cement; characteristics of good cement

5.2 Manufacture of ordinary cement: dry manufacturing process; wet manufacturing process

5.3 Classification of cements: different types of cements, their composition, properties and applications (ordinary Portland cement (OPC), rapid hardening cement, slow setting cement, Portland pozzolana cement (PPC), white cement, colored cement)

5.4 Hydration of cement and testing: Formation of glue, chemical bonding, setting time (initial and final); field test; laboratory tests (fineness test, consistency test, initial and final setting time test, soundness test, compressive and tensile strength test)

5.6 Admixtures: Types of admixture (water proofers, accelerators, retarders, plasticizers, air entraining agents), uses of admixtures

Unit 6 Mortar (2 hours)

6.1 Function, classification and uses of different types of mortar

6.2 Properties of mortar: workability, inertness, setting and hardening, adhesion

6.3 Preparation (hand mixing, machine mixing), storage and handling of mortar

6.4 Selection of mortar for different construction works: selection criteria; characteristics of a good mortar

6.5 Testing of mortars: crushing strength test, tensile strength test, adhesiveness test on building unit

Unit 7 Timber (3 hours)

7.1 Tree and timber: growth and structure of tree; properties (including mechanical) and use of timber; defects in timber (during growth of trees, after felling of trees); characteristics of good timber

7.2 Classification of tree and properties of wood, hard wood, soft wood

7.3 Seasoning of timber: definition and importance of seasoning; types of seasoning (natural and artificial seasoning)

7.4 Deterioration and preservation of timber: deterioration (physical, chemical, biological); types of preservatives; methods of preservation

7.5 Commercial product of timber: veneers and ply wood; boards (laminated boards, fiber boards, block boards, and batten boards); impreg and compreg timbers

7.6 Bamboo: properties (including mechanical) of bamboo; structural use of bamboo

Unit 8 Metals and Alloys (4 hours)

8.1 Metals: classification (ferrous and nonferrous metals); properties (physical, chemical, mechanical, electrical, thermal, magnetic)

8.2 Sources, composition, properties and uses of ferrous metals: pig iron, cast iron, wrought iron, steel, alloys of steel

8.3 Sources, properties and uses of nonferrous metals: aluminum, copper, lead, tin, zinc, magnesium, nickel

8.4 Heat treatment process and its importance in metals: annealing, normalizing, quenching or hardening, tempering, surface hardening (case hardening, nitriding, cyaniding, flame/ induction/laser hardening), defects in heat treatments

8.5 Commercial forms of metals and their uses: sheets, channel sections (I, C, angle, tubular), bars

8.6 Corrosion and its prevention in steel: theory of corrosion and its prevention with enameling; applying metal coatings – galvanizing, tin plating, electroplating; applying coatings – painting and tarring.

Unit 9 Paints and Varnishes (3 hours)

9.1 Paints: function and ingredients of paints; characteristics of good paint

9.2 Type, composition, properties and uses of paints: Oil paints; Aluminum paints; Asbestos paints; Bituminous paints; Cellulose paints; Cement paints; Colloidal paints; Emulsion paints; Enamel paints; Graphite paints; Silicate paints; Anticorrosion paints; Plastic paints; Synthetic rubber paints; Distempers

9.3 Varnishes: function and ingredients of varnishes; characteristics of good varnishes

9.4 Type, composition, properties and uses of varnishes: Oil varnish; Turpentine varnish; Spirit varnish; Water varnish; Asphalt varnish; Spar varnish; Flat varnish

9.5 Process of application of different paints and varnishes: application in new surfaces; application in old surfaces

9.6 Defects in paints and varnishes: effects of background (dampness, cleanness movement reactions); effects of weather (blistering, peeling, checking, cracking, flaking, chalking, alligatoring, wrinkling, running and sagging, mildew, bloom, flashing, grining)

Unit 10 Miscellaneous Materials (4 hours)

10.1 Asphalt: origin, composition, properties, types and uses

10.2 Bitumen: origin, composition, properties, types and uses

10.3 Tar: origin, composition, properties, types and uses

10.4 Composition, properties, types and uses of :– glass, plastic materials, rubber materials, insulating materials, gypsum products, adhesive and sealant materials, anti-termite materials, water proofer, geosynthetics, fibers

10.5 Composite materials: composition, properties, types and uses of – cement steel reinforced concrete, fiber reinforced plastics, fiber reinforced cement concrete and plastics, metal matrix composite

10.6 Emerging materials: Calcium silicate bricks; Concrete blocks; Aerated Autoclave Concrete blocks (AAC blocks); Interlocking Compressed Stabilized Earth Blocks (Interlocking CSEB), panels and boards

Practical (15 Hours)

There shall be related practical study in class. Practical work shall be as given below considering specified chapters.

1. Water absorption test of (i) Brick, and (ii) Stone (2 hours)
2. Bulk density test of (i) Brick, (ii) Cement, (iii) Sand, and (iv) timber (2 hours)
3. Specific gravity test of (i) Cement, (ii) Sand, (iii) Aggregate and (iv) Brick (3 hours)
4. Consistency and setting time (initial and final) of test of cement (4 hours)
5. Fineness and soundness test of cement (2 hours)
6. Compressive strength test of (i) Brick (ii) Mortar Cube, (iii) Cement Cube, and (iv) concrete cube (2 hours)

Reference

1. Duggal, S. K. (2008). Building Materials. New Delhi: New Age International (P) Ltd., Publishers.

2. Mamlouk, M. S., & Zaniewski, J. P. (2018). Materials for Civil and Construction Engineers. Harlow: Pearson Education Limited.

3. Rajput, R. K. (2004). Engineering Materials. S. Chand & Company Ltd

4. Singh, P. (2010). Civil Engineering Materials. New Delhi: S K Kataria & Sons

5. Thornton, P. A., & Prentice, V. J. (1985). Fundadmental of Engineering Materials . Hall Publishing Company.

Evaluation Schedule:

The final evaluation will have questions from all units. The marks distribution from different units shall be as follows:

Units	Unit Title	Scheduled Hours	Marks
Unit 1	Basics of Civil Engineering Materials	2	2
Unit 2	Stones and aggregates	3	3
Unit 3	Clay and Clay Products	3	3
Unit 4	Lime and pozzolanic materials	2	2
Unit 5	Cement	4	4
Unit 6	Mortar	2	2
Unit 7	Timber	3	3
Unit 8	Metals and Alloys	4	4
Unit 9	Paints and Varnishes	3	3
Unit 10	Miscellaneous Materials	4	4
	Total	**30**	**30**

Note: The marks distribution shown in the table above might be subjected to minor changes.

RAJARSHI JANAK UNIVERSTIY
Faculty of Science, Technology & Engineering

Subject: Engineering Drawing II
Level: Bachelor in Engineering
Year: I
Semester: II

Course Code: ME 104
Credit Hours: 1L+0Tu+3P
Lecture Hours: 45 Hours

Course Objective:

To develop the concept of sectional views, pictorial drawing, and working drawing. To make familiar with basic symbols used in different engineering practices.

	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	100
Cr	1	0	3		60	-	40	

Unit 1: Orthographic Views and Sectional Views (Conventional Practices) (12 hours)

1.1. Orthographic Views: Half views and partial views, treatment of unimportant Intersections, Aligned views, Treatment of Radially Arranged Features, and Representation of Fillets and Rounds.
1.2. Sectional views: Conventions for Ribs, Webs, and Spokes in sectional views, Broken Section, Removed Section, Revolved Section, Offset Section, Phantom Section, and Auxiliary section views.
1.3. Simplified Representation of Standard Machine Elements.

Unit 2: Pictorial Drawing (20 hours)

2.1 Introduction: Classification, Advantages and Disadvantages
2.2 Axonometric Projection: Isometric Projection and Isometric Drawing
- 2.2.1 Isometric Drawing Procedure
- 2.2.2 Isometric and Non-isometric Lines and Surfaces
- 2.2.3 Angles, Circles, circular Arcs, Irregular Curves in Isometric drawings
- 2.2.4 Isometric sectional views

2.3 Oblique Projection and Oblique Drawing
- 2.3.1 Procedure for Making Oblique Drawing
- 2.3.2 Rules for Placing Objects in Oblique Drawing
- 2.3.3 Angles, Curves, and Circular Arcs in Oblique Drawing

2.4 Perspective projection
- 2.4.1 Introduction to Perspective Projection, Difference with Isometric Projection
- 2.4.2 Various Terms Used in Perspective Projection
- 2.4.3 Types: Parallel and Angular Perspective

2.4.4 Selection of Station Point

Unit 3: Basic concepts with different Machine components and conventions (8 hours)

3.1 Limit Dimensioning and Machining Symbols

3.1.1 Limits, Fits and Tolerances

3.1.2 Machining Symbols and Surface Finishing

3.2 Nuts, Bolts and Threads

3.2.1 Terms and nomenclatures of threads, forms of screw threads

3.2.2 Detailed and Simplified Representation: Internal and External Threads

3.2.3 Threads dimensioning

3.2.4 Conventional Symbols for Nuts and Bolts, Standard Nuts and Bolts: Hexagonal Head and Square Head

3.3 Welding and Riveting

3.3.1 Welding symbols, Types of welds, and Types of welded joints

3.3.2 Rivet Symbols, Types of Rivet joints: Lap and Butt joints

3.3.3 Forms and Proportions for Rivet Heads

3.4 Familiarization with Graphic symbols and conventions

3.4.1 Standard symbols for Civil, Structural, and Agricultural components

3.4.2 Standard symbols for Electrical, Mechanical, Computer, Electronics, communications and Industrial components

3.4.3 Topographical symbols

3.5 Piping symbols and piping drawing

Unit 4: Detailed and Assembly Drawings (20 hours)

4.1 Introduction: Working drawing

4.2 Components of working drawing: Drawing Layout, Bill of materials, Drawing numbers

4.3 Detailed and Assembly Drawings: V-block Clamp, Centring Cone, Couplings, Bearings Antivibration Mounts, Stuffing Boxes Srew Jacks, etc.

Practicals:

1. Practices on Orthographic and sectional Views (both Full and Half Sections)
2. Isometric Drawings: consisting of curved surfaces and sections
3. Oblique Drawing
4. Perspective Drawings
5. Graphical Symbols: Limit, Fit, Tolerances and surface roughness and other engineering fields
6. Detail Drawing and Assembly Drawings
7. Building Drawing

References

1. N.D. Bhatt, “Machine Drawing”, Charotar Publishing House, India.
2. P.S. Grill, “Machine Drawing”, S.K. Kataria and Sons, India
3. R.K. Dhawan, “Machine Drawing”, S. Chand and Company Limited, India.
4. W.J. Luzaddar, “Fundamentals of Engineering Drawing”, Prentice Hall.

5. T.E. French, C.J. Vierck, and R.J. Foster, “Engineering Drawing and Graphic Technology”, Mc Graw Hill Publishing Co.
6. F.E. Giescke, A. Mitchell, H.C. Spencer, and J.T. Dygdone, “Technical Drawing”, Macmillan Publishing Co.

Distribution of marks:
The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

		Scheduled Hours	**Marks and Remarks**
Unit 1	**Orthographic Views and Sectional Views**	12	8
Unit 2	**Pictorial Drawing**	20	13
Unit 3	**Basic concepts with different Machine components and conventions**	8	5
Unit 4	**Detailed and Assembly Drawings**	20	14
Total		**60**	**40**

Note: The marks distribution shown in the table above might be subjected to minor changes.

RAJARSHI JANAK UNIVERSTIY
Faculty of Science, Technology & Engineering

Subject: Engineering Physics **Course Code: SH 106**
Level: Bachelor in Engineering **Credit Hours: 3**
Year: I **Lecture Hours: 45 Hours**
Semester: II

Course objectives: To provide the concept and knowledge of physics with the emphasis of present day application. The background of physics corresponding to +2 or Proficiency Certificate Level is assumed.

Teaching schedule Hours/week				Examination scheme				
				Internal assessment		Final		Total marks
Cr	Theory	Tutorial	Practical	Theory	Practical	Theory	Practical	125
	4	2	2	40	10	60	15	

1. **Mechanical Oscillation(6 hours)**

   1.1 Physical pendulum
   - 1.1.1 Introduction
   - 1.1.2 Bar pendulum
   - 1.1.3 Interchageability of point of suspension and point of oscillation
   - 1.1.4 Minimum time period in case of physical pendulum
   - 1.1.5 Torsional pendulum

   1.2 Oscillation
   - 1.2.1 Free oscillation
   - 1.2.2 Damped oscillation
   - 1.2.3 Difference between free and damped oscillation
   - 1.2.4 Energy in damped oscillation
   - 1.2.5 Forced oscillation and resonance
   - 1.2.6 Sharpness of resonance
   - 1.2.7 Quality factor

2. **Acoustics(3 hours)**

   2.1 Introduction
   - 2.1.1 Threshold of hearing and loudness
   - 2.1.2 Reverberation and reverberation time
   - 2.1.3 Absorption coefficient
   - 2.1.4 Sabine's Law
   - 2.1.5 Conditions for good acoustics

   2.2 Ultrasonic
   - 2.2.1 Introduction
   - 2.2.2 Production of ultrasonics(piezoelectric)
   - 2.2.3 Test of structure and materials
   - 2.2.4 Medical uses
   - 2.2.5 Applications of ultrasonics

3. **Relativity [6 hours]**

3.1 Frame of reference;
3.2 Inertial and non – inertial frame of references
3.3 Postulates of special theory of relativity
3.4 Lorentz transformation equations; Length contraction; Time dilation. Twin paradox
3.3 Simultaneity; Relativistic mass; Mass and Energy
3.4 Space – time diagram

4. **Optics (18 hours)**

4.1 Geometrical Optics(3 hours)
4.1.1 Lenses, combination of lenses
4.1.2 Cardinal points
4.1.3 Chromatic aberration

4.2 **Laser (2 hours)**
4.2.1 Introduction
4.2.2 Laser and ordinary light, properties of laser production
4.2.3 Induced absorption, spontaneous and stimulated emission active medium, population inversion, metastable state, pumping
4.2.4 He-Ne laser,
4.2.5 Semiconductor laser
4.2.6 Uses of laser

4.3 **Fiber Optics (2 hours)**

4.3.1 Introduction
4.3.2 Acceptance angle and numerical aperture
4.3.3 Types of optical fibre: step index and graded index
4.3.4 Fiber transmission – single and multimode
4.3.5 Self-focusing
4.3.6 Applications of Optical fiber

4.4 **Physical Optics(12 hours)**
4.4.1 Interference
4.4.2 Intensity in double slit interference
4.4.3 Interference in thin films (reflected and transmitted light)
4.4.4 Fringes produced by wedge – shape thin film
4.4.5 Newton's rings (reflected and transmitted light)
4.4.6 Determination of wavelength of monochromatic light and refractive index given liquid by using Newton’s ring

4.5 Diffraction
4.5.1 Introduction: Fresnel and Fraunhoffer’s diffraction
4.5.2 Fraunhoffer’s diffraction at single slit and double slit
4.5.3 Intensity in single slit due diffraction
4.5.4 Intensity due to a single slit
4.5.5 Diffraction grating
4.5.6 X-ray diffraction, X-ray for material test

4.6 Polarization
4.6.1 Introduction Double refraction, Nichol prism

4.6.2 Wave plates (quarter and half wave plate)
4.6.3 Linearly, elliptical and circularly polarized light (qualitatively and quantitavely)
4.6.4 Optical activity, Specific rotation

5 **Electrostatics(8 hours)**

5.1 Electric field
5.1.1 Electric field due to an electric dipole (axial line and equatorial line)
5.1.2 Electric dipole in an external field
5.1.3 Electric field due to a linear quadrupole (along axial line)
5.1.4 Electric field due to continuous charge system (line of charge, ring of charge, and disc of charge)
5.2 Electric Potential
5.2.1 Potential due to electric dipole
5.2.2 Potential due to linear quadrupole
5.2.3 Potential due to continuous charge system (ring of charge and disk of charge)
5.2.4 Electrostatic potential energy
5.2.5 Capacitors,
5.2.6 Charging and discharging of capacitor
5.2.7 Capacitor with dielectric and Gauss law

6 **Electromagnetism(6 hours)**

6.1 **Electromagnetic induction:**
6.1.1 Hall effect
6.1.2 Cyclotron, Synchrotron
6.1.3 Faraday's law of electromagnetic induction and energy transformation
6.1.4 Induced electric field
6.1.5 Self-induction and mutual induction
6.1.6 LR circuit
6.1.7 Energy stored in a magnetic field and energy density
6.1.8 Induced Magnetic field: modified Ampere's law
6.1.9 Displacement current
6.1.10 Eddy current:
6.1.11 Itroduction
6.1.12 Induction stove

7 **Electromagnetic Waves(6 hours)**

7.1 Gauss divergence theorem and Stoke's theorem (statement only)
7.2 Maxwell's equations
7.2.1 Integral and differential form
7.2.2 Equation of continuity
7.2.3 Conversion of Maxwell's equation from integral to differential form and differential to integral form
7.2.4 Wave equations in free space and in medium
7.2.5 Speed of electromagnetic wave, Ratio of electric field and magnetic field
7.2.6 Poynting vector

8 **Photon and Matter Waves(6 hours)**

8.1 Quantum physics
8.1.1 Inadequacy of classical mechanics and need of quantum mechanics

8.1.2 Quantization of energy

8.2 Matter wave:
- 8.2.1 Electron and matter wave
- 8.2.2 de - Broglie wave equation
- 8.2.3 Group velocity and phase velocity
- 8.2.4 Relation between group velocity and phase velocity
- 8.2.5 Heisenberg uncertainty principle
- 8.2.6 Wave function and its significance

8.3 Schrodinger wave equation
- 8.3.1 Schrodinger wave equation (Time dependent and independent)
- 8.3.2 Probability distribution
- 8.3.3 One dimensional potential well
- 8.3.4 Barrier tunnelling (reflection and transmission coefficient)

Laboratory

1. To determine the acceleration due to gravity and the radius of gyration of the bar pendulum
2. To determine the modulus elasticity of the given material and moment of inertia of the circular disc about the wire as in an axis passing through its centre and perpendicular to its plane by using torsional pendulum.
3. To determine wavelength of sodium light using newton's ring
4. To determine the wavelength of LASER light using diffraction grating
5. To determine the capacitance of the given capacitor by the method of charging and discharging through resistor
6. To plot a graph between frequency and current in LCR series circuit and hence determine the quality factor of the circuit.
7. To determine the dielectric constant of the given material.

References:

1. Fundamentals of Physics: Halliday, Resnick, Walker (Latest Edition)
2. A text book of Optics: Brij Lal and Subrahmanyam (Latest edition)
3. Modern Engineering Physics: A. S.Basudeva
4. Engineering Physics: R. K.Gaur and S. L.Gupta
5. Waves and Oscillation: Brij Lal and Subrahmanyam

Evaluation Scheme:
There will be questions covering all the chapters in the syllabus. The evaluation scheme for the question will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	9	6
2	3	2
3	5	6
4	18	16
5	8	7
6	6	6
7	6	7
8	6	10
Total	60	60

***Note: There may be minor deviation in mark distribution.**

RAJARSHI JANAK UNIVERSTIY
Faculty of Science, Technology & Engineering

Subject: Fundamentals of Electrical and Electronics Engineering **Course Code: EX 101 & EE 101**
Level: Bachelor in Engineering **Credit Hours: 3L + 1 Tu + 2P**
Year: I **Lecture Hours: 45 Hours**

Semester: II

Course Objectives:
The course aims to provide a comprehensive understanding of the fundamentals of electrical engineering,
encompassing circuits, components, and related laws, and principle of operation of common electrical machines. The course also aims to impart knowledge on the basics of semiconductor devices and their application in electronic circuits.

	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	125
Cr	3	1	2	40	10	60	15	

Course Contents:

Unit 1 Fundamentals of Electrical and Electronics Circuits (12 hours)
1.1 Current and Potential
1.2 Circuit Components: Source, Conductor, Resistor, Inductor, Capacitor
1.3 Ohms Law
1.4 Series and Parallel Circuits
1.5 Kirchhoff's Law and its application
    1.5.1 Nodal Analysis
    1.5.2 Mesh Analysis
1.6 Introduction to AC Circuits and Parameters
    1.6.1 Generation of AC Voltage
    1.6.2 Waveforms
    1.6.3 Average value
    1.6.4 RMS Value
1.7 Single Phase AC Circuit Analysis with R, RL, RC and RLC Load
1.8 Three phase AC Circuits
    1.8.1 Waveform and Advantage
    1.8.2 Line and Phase Quantities in Star and Delta Connection
    1.8.3 Voltage & current computation in Balance Circuits
    1.8.4 Power Measurement in Three Phase Circuits

Unit 2 Electrical Machines (14 hours)

2.1 Faraday's Law of Electromagnetic Induction
2.2 Dynamically and Statically Induced EMFs
2.3 Transformer
- 2.3.1 Introduction of Single-Phase Transformer
- 2.3.2 Working Principle of Transformer
- 2.3.3 Components of Transformer
- 2.3.4 Transformation Ratio
- 2.3.5 EMF Equation of Transformer
- 2.3.6 Types of Transformers
- 2.3.7 Load and No-Load Operation
- 2.3.8 Ideal and Practical Transformer
- 2.3.9 Losses and Efficiency
- 2.3.10 Applications

2.4 Three phase induction motor
- 2.4.1 Construction
- 2.4.2 Rotating Magnetic Field
- 2.4.3 Working Principle
- 2.4.4 Direction of Rotor and Slip
- 2.4.5 Types of Rotors
- 2.4.6 Standstill and Running Condition
- 2.4.7 Modes of Operation
- 2.4.8 Torque Equations
- 2.4.9 Torque-Slip Characteristics
- 2.4.10 Applications

2.5 DC Motors
- 2.5.1 Construction
- 2.5.2 Working Principle
- 2.5.3 Back EMF and its Significance
- 2.5.4 Power Torque Relationships
- 2.5.5 Types of Motors
- 2.5.6 Losses and Efficiency
- 2.5.7 Applications

2.6 Synchronous Generator
- 2.6.1 Construction
- 2.6.2 Working Principle
- 2.6.3 EMF Equation
- 2.6.4 Applications

Unit 3 Introduction to Electronics Engineering (11 hours)

3.1 Semiconductor and Doping
3.2 Introduction to Diode
3.3 Characteristics of PN junction diode
3.4 Half-wave and full-wave rectifiers
3.5 Zener Effect
3.6 Zener diode and its characteristics
3.7 Zener diode as a Voltage regulation
3.8 Bipolar junction transistor
- 3.8.1 Biasing
- 3.8.2 BJT as a switch
- 3.8.3 BJT as an amplifier

3.9 Introduction to Digital Electronics
3.10 Logic Gates and Boolean Algebra

Unit 4 Electrical Installations (8 hours)
4.1 Consumer Power Supply System
4.2 Overview of Electrical Wiring Components: Switches, Sockets, and Distribution Boards
4.3 Protective devices, their constructions and Sizing,
    4.3.1 Fuse
    4.3.2 MCB
    4.3.3 MCCB
4.4 Wires and Power Cable
4.5 Types of Wiring System
4.6 Determination of Size of Conductor
4.7 Earthing System and its importance
4.8 Electrical Safety Rules

Tutorial (15 hours)
The tutorial sessions will focus on chapter-specific exercises aimed at enhancing the understanding and application of the theory to solving practical problems.

Laboratory
1. Verification of Ohms law and Kirchhoff's law
2. Measurement of AC quantities using oscilloscope and study phase relation of RL and RC load.
3. Measurement of line, phase and power in three-phase balanced load.
4. Load test on single phase transformer and torque-speed characteristics of induction machine.
5. Connection of electrical installations of residential buildings.
6. To study Characteristics of PN and Zener Diodes and perform basic operations using logic gates

Reference
1. **Mehta, V. K., and Mehta Rohit. Principle of Electrical Engineering and Electronics. S. Chand Publishing, 2014.**
2. **K.B. Raina S.K. Bhattacharya. Electrical Design Estimating and Costing, New Age Internation, 2007**.
3. Bhattacharya, S. K. Basic Electrical and Electronics Engineering I, Pearson Education India, 2010.
4. R. L. Boylestad, *Introductory Circuit Analysis,* Prentice Hall Inc
5. Floyd, Thomas L. Digital fundamentals, 10/e. Pearson Education India, 2011.

Evaluation Scheme:
The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

		Scheduled Hours	**Marks**
Unit 1	Fundamentals of Electrical and Electronics Circuits	12	16
Unit 2	Electrical Machines	14	18
Unit 3	Introduction to Electronics Engineering	11	14
Unit 4	Electrical Installations	8	12
Total			**60**

Note: The marks distribution shown in the table above might be subjected to minor changes.

RAJARSHI JANAK UNIVERSTIY
Faculty of Science, Technology & Engineering

Subject: Math – II Advanced Calculus **Course Code: SH 104**
Level: Bachelor in Engineering **Credit Hours: 3**
Year: I **Lecture Hours: 45 Hours**

Semester: II

Objectives of the Course:

- Understanding the polar coordinates, sketching the graph and finding the length, area of polar curves
- To explore the concept of calculus for multivariate functions, vector valued functions and advanced vector calculus and their applications
- Understanding the Fourier series and Fourier integrals

Credit Hours	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	100
3	3	2	-	40	-	60	-	

Course Contents:

Unit 1: Polar, Cylindrical and Spherical Coordinates [6 Hours]

1.1 Polar coordinates and relation with Cartesian coordinates, Symmetry, Graphs of polar equations,
1.2 Area and lengths in polar coordinates
1.3 Line, Circles and Conics in polar coordinates
1.4 Cylindrical coordinates and relation with Cartesian coordinates, Cylindrical coordinates and relation with Cartesian coordinates, Spherical coordinates and relation with Cartesian coordinates

Unit 2: Partial Derivatives [9 Hours]

2.1 Function of several variables, Domain and range, Graphs, Level Curves, and Contours of Functions of two variables, Function of three variables and level surfaces
2.2 Limit and continuity of function of two, Two path test for non-existence of limit
2.3 Partial Derivatives of function of two and three variables and geometrical interpretation for partial derivatives for two variables, Higher order partial derivatives and mix derivatives theorem statement only.
2.4 Chain rules for function of two and three intermediate and one independent variables, Chain rule for three intermediate and two independent variables, Implicit differentiation using partial derivatives
2.5 Directional derivative and geometrical interpretation, Gradient vector and directional derivative as a dot product, properties of directional derivative
2.6 Tangent plane and normal lines, Linearization of function of two and three variables
2.7 Local extreme values for function of two variables, first and second derivative tests for local extreme values, Absolute maxima and minima values for function of two variables and finding those values in the bounded and closed regions

2.8 Method of Lagrange multiplies for constraint optimization problems,
2.9 Taylor's series formula for function of two variables

Unit 3: Multiple Integrals [8 Hours]

3.1 Double integrals over a rectangular regions and volume of solid, Fubini's Theorem (First Form)
3.2 Double integrals over general regions and volume of solids, Fubini's Theorem (Stronger Form), Finding limits of interactions, Change of order of integration, Properties of double integrals,
3.3 Area by double integrals, Double integrals in polar forms, Finding limits of integrations, Area in polar coordinates, Cartesian Integrals into Polar Integrals,
3.4 Triple integrals in rectangular coordinates, Volume by triple integrals, Triple Integrals in Cylindrical and Spherical Coordinates
3.5 Applications: Finding mass, first moments, center of mass, Moments of inertia of two dimensional plates

Unit 4: Vector Valued Functions [8 Hours]

4.1 Vector functions and space curves, Limit and continuity of vector function, Derivative of vector function and motion of particle in a space, Differentiation rules
4.2 Definite and indefinite integration of vector functions and application in motion in space Arc length of space curve, Arc length parameter with base point
4.3 Speed on a smooth curve, Unit tangent vector, curvature of a plane curve, Principal unit vector, radius and circle of curvature
4.4 Curvature and normal vectors for space curve, Bio normal vector, Torsion, TNB Frame and three planes determined by TNB frame
4.5 Alternative formulas to calculate curvature and torsion and related problems

Unit 5: Vector Integral Calculus [9 Hours]

5.1 Line integrals of a scalar function over plane and space curves, Mass and moments calculations
5.2 Vectors fields, Gradient vector, Line integrals of vector fields, Work done by force over space curve
5.3 Flow integrals and circulations for vector fields, Flux across a simple closed plane curve
5.4 Path Independence, Conservative Fields, and Potential Functions, Fundamental Theorem of Line Integrals, Finding potential of conservative fields, Exact differential forms and integrals
5.5 Curl and divergence of vector field, Green's Theorem Statements (Tangential Form and normal forms) and related problems
5.6 Parametrizations of Surfaces and surface area, Implicit surfaces and surface area and related problems, Surface integrals of scalar functions, surface integral of vector fields
5.7 Statements of Stokes' Theorem, Divergence Theorem and related problems

Unit 6: Fourier Series [5 Hours]

6.1 Periodic functions and periods, Fourier series and Fourier coefficients of a function of period 2π
6.2 Functions having arbitrary period 2L and its Fourier series representation, Fourier Cosine and Fourier Sine series, Half-range expansions,
6.3 Fourier integral and its applications, Fourier cosine and Fourier Sine integrals,

Text Books:

1. "Thomas' Calculus" by George B. Thomas Jr., Maurice D. Weir, and Joel R. Hass, Pearson India
2. Advanced Engineering Mathematics" by Erwin Kreyszig, Wiley

Reference Books:

1. Calculus: Early Transcendentals" by James Stewart, Publisher: Cengage Learning India
2. Advanced Engineering Mathematics by H. K. Dass, S. Chand, New Delhi.
3. A Text Book of Calculus II by Narayan Prasad Pahari, Santosh Ghimire, Dr. Jeevan Kafle, Arun Kumar Bhandari, Madav Prasad Poudel, Prem Gurung, Durgesh Ojha, Publisher: Asmita Publication, Kathmandu, Nepal
4. A Text Book on Engineering Mathematics Volume II by P. R. Pokharel, H. D. Chaudhary, S. P. Shrestha, Publisher: Vidyarthi Pustak Bhandar, Kathmandu, Nepal

Evaluation Scheme:

The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

Units	Topics	Scheduled Hours	Marks
1	Polar, Cylindrical and Spherical Coordinates	6	7
2	Partial Derivatives	9	12
3	Multiple Integrals	8	11
4	Vector Valued Functions	8	11
5	Vector Integral Calculus	9	12
6	Fourier Series	5	7
Total		**45 Hours**	**60 Marks**

Note: The marks distribution shown in the table above might be subjected to minor changes.

RAJARSHI JANAK UNIVERSTIY
Faculty of Science, Technology & Engineering

Subject: Math – II Trigonometry and Analytical Geometry **Course Code: SH 105**
Level: Bachelor in Engineering **Credit Hours: 3**
Year: I **Lecture Hours: 45 Hours**

Semester: II

Course Objective:

- To develop students' ability to visualize and understand geometric shapes, figures, and spatial relationships in two and three dimensions.
- To acquire knowledge in coordinate transformations, conic sections, general equations of the second degree, planes, 3D lines, spheres, and spherical trigonometry.
- To improve analytical and problem-solving abilities for real-world engineering applications.

Credit Hours	Teaching Schedule Hours/Week			Evaluation Scheme				
				Internal Evaluation		Final Evaluation		Total
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	100
3	3	2	-	40	-	60	-	

Course Description:

Unit 1: Transformation of Coordinates **[5 Hours]**

1.1 Translation and rotation of axes
1.2 Combination of translation and rotation of axes
1.3 Invariants
1.4 Removal of the first-degree terms
1.5 Removal of xy −terms

Unit 2: General Equation of Second Degree **[8 Hours]**

2.1 General equation of second degree and the associated conics
2.2 Nature of the conic
2.3 Axis and Latus rectum of the parabola
2.4 Centre of a conic
2.5 Lengths and position of the axes of central conic $ax^2 + 2hxy + by^2 = 1$
2.6 Equations of tangent and normal
2.7 Equations of Chord of contact and Polar
2.8 Equation of Diameters and Conjugate Diameters

Unit 3: Conics in polar forms **[7 Hours]**

3.1 Introduction to Polar Coordinates
3.2 Polar Equation of a conic
3.3 Equation of Directrix of a conic

3.4 Equation of chord joining two points of a conic
3.5 Chord of contact of a point
3.6 Equations of tangent and normal
3.7 Equation of the asymptotes of a conic
3.8 Pole and equation of Polar of a point

Unit 4: Plane **[6 Hours]**

4.1 Equation of plane in different forms
4.2 Angle between two planes
4.3 Plane through three points
4.4 Plane through the intersection of two planes

Unit 5: Straight line in 3D **[6 Hours]**

5.1 General equation of a straight line
5.2 Equation of a straight line in a symmetrical form
5.3 Transformation from general form to the symmetrical form
5.4 Angle between the line and a plane
5.5 Coplanar Lines
5.6 Shortest distance

Unit 6: Sphere **[6 Hours]**

6.1 General Equation of a Sphere
6.2 Equation of a sphere on the line joining two given points as a diameter
6.3 Intersection of two spheres
6.4 Sphere through a given circle
6.5 Equation of a tangent plane and condition of tangency

Unit 7: Spherical Trigonometry **[7 Hours]**

7.1 Great circle and small circle
7.2 Axis and pole of a circle
7.3 Properties of poles
7.4 Spherical radius, Secondaries
7.5 Spherical angle and its measurement
7.6 Length of arc of a small circle
7.7 Spherical triangle, Polar triangle and their properties
7.8 Fundamental formulae with proofs

Text Books:

1. Analytical Geometry (Two Dimensional) by M.R. Joshi and Jeevan Kafle, Sukunda Pustak Bhawan, Kathmandu
2. A Text Book of Three Dimensional Geometry by Y.R. Sthapit and B.C Bajracharya, Sukunda Pustak Bhawan, Kathmandu
3. Spherical Trigonometry and Spherical Astronomy by B. Singh and H. D. Pandey, Pragati Prakashan, Meerut. India

Reference Books:

1. Geometry of Three Dimensional Co-ordinates by P. K. Jain and Khalil Ahmad, Wiley Eastern Ltd. New Delhi
2. A Text Book of Spherical Trigonometry and Spherical Astronomy by D. S. Pandey and S. K. D. Dubey Swastik Publication, India

Evaluation Scheme:

The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

Units	Topics	Scheduled Hours	Marks
1	Transformation of Coordinates	5	7
2	General Equation of Second Degree	8	11
3	Coins in polar forms	7	9
4	Plane	6	8
5	Straight line 3D	6	8
6	Sphere	6	8
7	Spherical Trigonometry	7	9
Total		**45 Hours**	**60 Marks**

Note: The marks distribution shown in the table above might be subjected to minor changes.