VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY HYDERABAD
B.TECH. I YEAR
(Common to ME and AE)

I SEMESTER   **R18**

Course Code	Title of the Course	L	T	P/D	Contact Hours/ Week	Credits
18BS1MT01	Advanced Calculus	3	1	0	4	4
18BS1PH01	Applied Physics	3	1	0	4	4
18ES1CS01	Programming through C	3	0	0	3	3
18ES2CS01	Programming through C Laboratory	0	0	4	4	2
18BS2PH01	Applied Physics Laboratory	0	0	3	3	1.5
18ES3ME01	Engineering Graphics	1	0	5	6	3.5
18PW4ME01	Design Sensitization	0	0	2	2	1
Total		**10**	**2**	**14**	**26**	**19**
18MN6HS01	Induction Programme	-	-	-	-	-

II SEMESTER   **R18**

Course Code	Title of the Course	L	T	P/D	Contact Hours/ Week	Credits
18BS1MT02	Linear Algebra and Ordinary Differential Equations	3	1	0	4	4
18BS1CH01	Engineering Chemistry	3	1	0	4	4
18ES1ME01	Engineering Mechanics	3	1	0	4	4
18HS1EN01	English	2	0	0	2	2
18HS2EN01	English Language Communication Skills Laboratory	0	0	2	2	1
18BS2CH01	Engineering Chemistry Laboratory	0	0	3	3	1.5
18ES2ME01	Workshop Practices	1	0	3	4	2.5
Total		**12**	**3**	**8**	**23**	**19**

L – Lecture   T – Tutorial   P – Practical   D – Drawing

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to all branches	L	T/P/D	C
	3	1	4

(18BS1MT01) ADVANCED CALCULUS

COURSE PREREQUISITES: None

COURSE OBJECTIVES: To learn
- Geometrical Approach to the mean value theorems and their application to the mathematical problems.
- Concept of Sequence and Series
- Evaluation of improper integrals using Beta and Gamma functions
- Evaluation of multiple integrals and their applications
- Basic properties of vector point function and their applications to line, surface and volume integrals

COURSE OUTCOMES: Students will be able to
CO-1: Solve problems involving mean value theorems
CO-2: Analyze the nature of convergence of sequence and series
CO-3: Evaluate integrals using special functions and change of variables
CO-4: Evaluate double and triple integrals
CO-5: Transform line integral to surface and surface to volume integrals

UNIT-I: Calculus of Single and Several Real Variables
Mean value theorems – Rolle's Theorem, Lagrange's Mean value theorem Cauchy's Mean value theorem**,** Taylor's expansion and McLaurin's expansion of functions (without proofs). Partial differentiation, partial derivatives of first and second order in terms of partial derivatives, change of variables, Jacobian, Taylor's theorem of two variables (without proof). Maxima and Minima of two variables, Lagrange's method of undetermined multipliers.

UNIT-II: Sequences and Series
Sequence: Definition of a Sequence, limit; Convergent, Divergent and Oscillatory sequences. Series: Convergent, Divergent and Oscillatory Series; Series of positive terms; Comparison test, p-test, D-Alembert's ratio test; Raabe's test; Cauchy's Integral test; Cauchy's root test; logarithmic test. Alternating series: Leibnitz test; Alternating Convergent series: Absolute and Conditionally Convergence, Power series**.**

UNIT-III: Improper Integrals
Definition of Improper Integral: Beta and Gamma functions, Relation between the Beta and Gamma functions (without proof) and their applications, Standard forms of beta functions.

UNIT-IV: Multiple Integrals
Evaluation of Double Integrals (Cartesian and polar coordinates); change of order of integration (only Cartesian form); Evaluation of Triple Integrals: Change of variables

(Cartesian to polar) for double and (Cartesian to Spherical and Cylindrical polar coordinates) for triple integrals. Applications: Areas (by double integrals) and volumes (by double integrals and triple integrals).

UNIT-V: Vector Differential Calculus
Vector point functions and scalar point functions. Gradient, Divergence and Curl. Directional derivatives, Tangent plane and normal line. Vector Identities (without proofs). Scalar potential functions. Solenoidal and Irrotational vectors.

UNIT-VI: Vector Integral Calculus
Line, Surface and Volume Integrals. Theorems of Green, Gauss and Stokes (without proofs) and their applications.

TEXT BOOKS:
1. Advanced Engineering Mathematics-Erwin Kreyszig, 9th edition; Publisher: John Wiley
2. Higher Engineering Mathematics – B.V. Ramana; Publisher: Tata McGraw Hill, New Delhi,11th Reprint-2010

REFERENCES:
1. Calculus and Analytic Geometry - Thomas and Finney, 9th edition; Publisher: Pearson Education, 2002.
2. Higher Engineering Mathematics - B.S. Grewal, Publisher: Khanna, 36th Edition-2010.
3. Elementary Analysis: The Theory of Calculus - Kenneth Ross; Publisher: Springer.
4. Advanced Engineering Mathematics - Peter 'O' Neil, Publisher: Cengage Learning.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to CE, ME & AME

L	T/P/D	C
3	1	4

(18BS1PH01) APPLIED PHYSICS

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- To comprehend various phenomena of light- Interference and Diffraction
- To understand the basic principles, working of lasers and optical fibers
- To learn basic structures and X-ray diffraction
- To study polarization mechanisms in dielectrics
- To understand the magnetic and superconducting properties of materials

COURSE OUTCOMES: After completion of the course, the student is able to
CO-1: realize the importance of Interference in thin films and Fraunhofer diffraction.
CO-2: analyze the lasing action of various laser sources and describe propagation of light through optical fiber
CO-3: identify different types of crystals and importance of X-ray studies in crystals.
CO-4: understand the frequency dependence of different polarizabilities
CO-5: recognize applications of magnetic materials and superconductors

UNIT-I: Wave Optics
Superposition Principle, Coherence, Interference of light by wave front splitting and amplitude splitting; Interference in thin films by reflection, Newton's rings experiment by reflection- Calculation of wavelength, Fraunhofer diffraction from a single slit, Double slit diffraction, Diffraction grating (Qualitative), and a circular aperture.

UNIT-II: Lasers
Introduction, Characteristics of Lasers, Spontaneous And Stimulated Emission Of Radiation, Meta Stable State, Population Inversion, Lasing Action, Einstein's Coefficients And Relation Between Them, Ruby Laser, Helium-Neon Laser, Semiconductor Laser, Application of Lasers in Science, Engineering and Medicine.

UNIT-III: Optical Fibers
Principle of optical fiber (Total Internal Reflection) – Acceptance angle and acceptance cone – Numerical aperture –Types of fibers and refractive index profiles – Qualitative analysis of attenuation in optical fibers –Application of optical fibers: Optical fiber communication system.

UNIT-IV: Crystal Structures and XRD
Space lattice, UNIT- cell, Lattice parameters, Crystal systems, Bravais lattice, Atomic radius, Co-ordination number, Structures and Packing fractions of Simple Cubic, Body Centered Cubic, Face Centered Cubic, Hexagonal closed packed, Miller Indices for Crystal planes and directions, Inter planar spacing of orthogonal crystal systems,

Diffraction of X-rays by crystal planes and Bragg's law, Powder method, Applications of XRD.

UNIT-V: Dielectric Properties

Electric dipole, Dipole moment, Dielectric constant, Electronic, Ionic polarizations and calculation of their polarizabilities, Orientation Polarization (qualitative), Frequency dependence of Polarization- Internal fields, Claussius – Mossotti equation, Piezo and Ferro electricity.

UNIT-VI: Magnetic Materials and Superconductors

Permeability, Field intensity, magnetic field induction, Magnetization and Magnetic susceptibility – Origin of magnetic moment, Bohr magneton – Classification of magnetic materials (Dia, Para and Ferro)- Domain theory of ferromagnetism, Hysteresis curve – Soft and Hard magnetic materials – Ferrites and their applications, Superconductivity phenomenon, Meissner effect, Critical fields and Persistent currents, Type I and Type II superconductors, Applications of Superconductors.

TEXT BOOKS:

1. Physics Vol.2 by Halliday, Resnick and Krane ;John Wiley &Sons
2. Engineering Physics by R.K. Gaur and S.L. Gupta; Dhanpat Rai and Sons
3. Engineering Physics, B.K. Pandey and S. Chaturvedi, Cengage Learning.

REFERENCES:

1. A Textbook of Engineering Physics, Dr.M.N. Avadhanulu and Dr P.G. Kshirsagar, S. Chand & Company PVT Ltd.
2. A. Ghatak, "Optics", McGraw Hill Education, 2012.
3. Applied Physics- P.K. Mittal, IK International Publishing house (Pvt. Ltd).
4. Introduction to Solid State Physics by Charles Kittel (Publishers: John Wiley & Sons)
5. Engineering Physics by P.K Palanisamy, Scitech Publications (India) Pvt. Ltd.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to all branches

L	T/P/D	C
3	0	3

(18ES1CS01) PROGRAMMING THROUGH C

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- **Relate** basics of programming language constructs and problem solving techniques
- **Classify** and implement derived data types
- **Analyze** and develop effective modular programming
- **Construct** mathematical problems and real time applications using C language

COURSE OUTCOMES: At the end of course, the student will learn
CO-1: To translate the algorithms to programs (in C language).
CO-2: To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
CO-3: To use arrays, pointers and structures to formulate algorithms and programs.
CO-4: To apply programming to solve simple numerical method problems, namely root finding of function, differentiation for function and simple integration.

UNIT-I: Introduction to Programming
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.). Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flow chart / Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, syntax and logical errors in compilation, object and executable code .Arithmetic expressions and precedence

UNIT-II: Conditional Branching and Loops
Writing and evaluation of conditionals and consequent branching Iteration and loops Arrays (1-D, 2-D), Character arrays and Strings

UNIT-III: Basic Algorithms
Searching, basic sorting algorithms (bubble, insertion and selection), finding roots of equations, notion of order of complexity through example programs (no formal definition required)

UNIT-IV: Functions
(Including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference.
Recursion: Recursion, as a different way of solving programs. Example programs, such as finding factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT-V: Structures
Defining structures and array of structures.
Pointers: idea of pointers, defining pointers, use of pointers in self-referential structures, notation of linked list (no implementation), dynamic memory allocation.

UNIT-VI: File Handling
Basic concepts, text files and binary files, file input/output operations, random access of files, command line arguments.

TEXT BOOKS:
1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.

REFERENCES:
1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to all branches	L	T/P/D	C
	0	4	2

(18ES2CS01) PROGRAMMING THROUGH C LABORATORY

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- **Gain** a working knowledge of C programming to write modular, efficient and readable C programs by Identifying the structural elements and layout of C source code.
- **Declare** and **manipulate** single and multi-dimensional arrays of the C data types and derived data types like structures, unions.
- **Use** functions from the portable C library and to describe the techniques for creating program modules using functions and recursive functions.
- **Manipulate** character strings in C programs. Utilize pointers to efficiently solve problems

COURSE OUTCOMES: At the end of course, students will be able to
CO-1: Use various data types for a specified problem
CO-2: Design, implement, debug a given problem using appropriate language constructs
CO-3: Implement programs using modular approach, file I/O
CO-4: Solve a given problem using C language.

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment.

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures.

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.t., sum of series.

Tutorial 5: 1D arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and strings
Lab 6: Matrix problems, string operations.

Tutorial 7: Functions, call by value:

Lab 7: Simple functions.

Tutorial 8 and 9: Numerical methods (Root finding, numerical differentiation, numerical integration):

Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls.

Lab 10: Recursive functions.

Tutorial 11: Pointers, structures and dynamic memory allocation.

Lab 11: Pointers and structures

Tutorial 12: File handling

Lab 12: File operations.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to CE, ME & AE	L	T/P/D	C
	0	3	1.5

(18BS2PH01) APPLIED PHYSICS LABORATORY

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- To practically learn interaction of light with matter through physical phenomena like interference, diffraction and dispersion.
- To understand the periodic motion and formation of standing waves and know the characteristics of the capacitors and resistors.
- To experience the mechanical oscillations and resonance phenomena
- To verify Biot –Savart law
- To compare the experimental results with the class room learning.

COURSE OUTCOMES: After completion of the course, the student is able to
CO-1: demonstrate the optical phenomena with formation of Newton Rings, pure spectrum through prism and to evaluate grating parameters.
CO-2: illustrate periodic motion by measuring rigidity modulus of a material and also discharging of a capacitor.
CO-3: differentiate resonance phenomenon in Melde's experiment and Sonometer experiment
CO-4: realize tangent law of magnetism.
CO-5: correlate the experimental results with the class room learning

1. **Spectrometer:** To determine the dispersive power of given prism using spectrometer
2. **Diffraction Grating:** To determine the wavelength of given laser and grating parameters
3. **Diffraction at Single Slit:** To determine the width of given wire.
4. **Newton's Rings Experiment:** To determine the radius of curvature of given plano convex lens
5. **Optical fiber:** Numerical aperture and acceptance angle of an optical fiber.
6. **Torsional pendulum:** To determine the rigidity modulus of a given wire
7. **Melde's experiment:** To determine the frequency of electrical vibrator using resonance phenomenon
8. **AC frequency by Sonometer**: To measure frequency of A.C mains
9. **RC Circuit:** To determine the time constant of RC circuit
10. **Stewart Gee's experiment:** To verify Biot - Savart's law
11. **Solar Cell:** To study the V-I characteristics of Solar cell
12. **Light Emitting Diode:** To study the V-I characteristics of LED

REFERENCES:
1. Engineering Physics laboratory Manual/Observation by Physics Faculty of VNRVJIET.
2. Laboratory Manual of Engineering Physics by Dr. Y. Aparna & Dr. K. Venkateswara Rao, VGS Publications.

3. Engineering Physics Practicals by Dr. B. Srinivasa Rao, Keshava Vamsi Krishna and K.S. Rudramamba by Laxmi Publications Pvt. Ltd (University Science Press), second edition

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to ME & AE

L	T/P/D	C
1	5	3.5

(18ES3ME01) ENGINEERING GRAPHICS

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- Know the conventions used in Engineering Drawing and comprehend the tools to be used in AutoCAD software
- Understand the importance of engineering scales and curves
- Learn to use the orthographic projections for points, lines, planes and solids in different positions
- Understand the development of sections and isometric projections
- Create simple solid models of various domain applications

COURSE OUTCOMES: At the end of the course, student will be able to
CO-1: Apply the concepts of scales and engineering curves in construction using AutoCAD
CO-2: Solve the problem of projections of points, lines, planes and solids in different positions using AutoCAD
CO-3: Obtain the development and sections of regular solids using AutoCAD
CO-4: Demonstrate construction of simple solid models of domain applications using AutoCAD

Introduction to AutoCAD Software:
The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.
Customisation & CAD Drawing:
Setting of drawing page and the printer, including scale settings, Setting of units and drawing limits; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles
Annotations, Layering &Other Functions:
Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, Layers to create drawings; Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print commands
Introduction to Computer Graphics:
Introduction to Computer Graphics; Modeling – Wireframe, Surface and Solid Modelling; Spatial Transformations - Move, Rotate, Zoom; Co-ordinate Systems; Model Viewing

UNIT-I: Introduction to Engineering Drawing
Principles of Engineering Graphics and their significance, Drawing instruments
Engineering Curves:
Conic sections: Ellipse, Parabola and Hyperbola including the Rectangular Hyperbola (General method only)
Cycloidal Curves & Involutes: Cycloid, Epicycloid, Hypocycloid and Involutes
Scales:
Plain, Diagonal and Vernier Scales

UNIT-II: Orthographic Projections
Principles of Orthographic Projections - Conventions
Projections of Points in all positions;
Projections of lines and planes inclined to both the planes - Auxiliary Views

UNIT-III: Projections of Regular Solids
Projections of Solids inclined to both the Planes - Auxiliary Views

UNIT-IV: Sections and Development of Surfaces of Right Angular Solids
Section and sectional views of right angular solids of Prism, Cylinder, Pyramid, Cone – Auxiliary Views
Development of surfaces of Right Regular Solids of Prism, Pyramid, Cylinder and Cone

UNIT-V: Isometric Projections
Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and Compound Solids;
Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions

UNIT-VI: Solid Modeling
Introduction to solid modeling; Creation of simple solid models; Part editing and two-dimensional documentation of models.
Demonstration of a simple team design project
Creation of engineering models of practical applications relevant to the domain and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids using Solid Modeling software
Applications could include but are not limited to: Table, Chair, Sink, Hinge, Remote Casing, CPU, Electrical Pole, Windows, Door Frames etc.

TEXT BOOKS:
1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. Narayana, K.L. & P. Kannaiah (2008), Textbook on Engineering Drawing, Scitech Publishers

REFERENCES:
1. AutoCAD Software Theory and User Manuals

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. I Semester– Common to ME & AE	L	T/P/D	C
	0	2	1

(18PW4ME01) DESIGN SENSITISATION

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- To create awareness of design among students of engineering
- To motivate students to think of design before implementing an engineering project
- To teach a systematic approach to identifying and defining a problem before brainstorming for a solution
- To instil a sense of significance towards applying creativity to product and service design

COURSE OUTCOMES: Upon completion of this course, the student shall be
CO-1: Learn to identify design principles from an engineering perspective
CO-2: Cultivate sensitivity towards design aspects in objects made by engineers and non-engineers, which are typically used in daily life
CO-3: Understand and create visual design elements to communicate more effectively
CO-4: Construct clear problem statements, understand the importance of validation, and design services creatively
CO-5: Develop fundamental team skills: working in teams and managing teams, strategizing tasks, and streamlining activities pertaining to a project

Students' Responsibilities:
1. Students will form teams of 3–5 members each, while working collaboratively throughout the semester.
2. Students will present and report the tasks to the class and to the concerned faculty members and design experts, using their oral and written communication skills as well as creativity and team skills.
3. Students must proactively engage in observing the objects and processes which are part of their daily life and society from a design perspective and discuss with peers to learn collaboratively.

MODULE-1: Design Overview and Motivation
History and Context of birth of Design; Design thinking: Introduction and Motivation; Various definitions and interpretations of design, Design Vocabulary; Design in Indian Context; Art and Design: Art in Design, Design beyond Art; Design in Creative Industries

MODULE-2: Design Sensitisation for Engineers
Design Engineering vs. Engineering Design, Examples of Engineering Design and Design Engineering in various engineering domains, Examples of design failures leading to bad products and services, Real-world examples of bad design that caused engineering and technological disasters, Domain-specific Engineering Design examples

MODULE-3: Design Thinking Foundations
The Design Double Diamond: Discover-Define-Develop-Deliver
User-centric design approaches: Importance of user-centricity for design, Empathisation, Empathy Maps, Data collection from users and for users, Data Validation
Responsible Innovation and Ethical Design: Ethics as foundation for design, Concern for environment and sustainability

MODULE-4: Communication Skills for Design, Culture and Art
Communication Media to express an idea: Visuals, Text, Voice and Audio, Infographics
General guidelines for a good Presentation: Target audience, slideshow templates, appropriate visual elements, presentation styles, guidelines
General guidelines for a good Report: Documentation classification, standards, styles, and templates
Modes of communication: Reports and documents, Presentation, poster, graphic, blog or website.
Understanding Art in Design: Need for creativity, Elements of Visual Design
Design Aesthetics: Influences and impressions of Colours, Shapes, Layouts, Patterns, and Fonts as Design Elements

MODULE-5: Applied Creativity and Design for Services
Methods to brainstorm solutions for user issues; Combining solutions to workable solution concepts; Identifying the user needs in a service-driven economy; Process Flows and Customer Experience considerations for designing and improving services; 5 Why's; Service Delivery Pathways

MODULE-6: Doing Design
Looking for a problem, Ideation and Rules of Ideation, Framing and stating the problem; Basic considerations of Prototyping/ Model Building, Basics of Testing and Validation, Incorporating feedback

TEXT BOOKS:
1. Daniel Ling, "Complete Design Thinking Guide for Successful Professionals", Create Space Independent Publishing, 2015 (ISBN: 978-1514202739)
2. Tim Brown, "Change by Design", Harper Business, 2012 (ISBN: 978-0062337382)
3. Jimmy Jain, "Design Thinking for Startups: A Handbook for Readers and Workbook for Practitioners", Notion Press, 2018 (ISBN: 978-1642495034)
4. Beverly Rudkin Ingle, "Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work", APress, 2013 (ISBN: 978-1430261810)

REFERENCES:
1. Donald A. Norman, "The Design of Everyday Things", *MIT Press*, 2013 (ISBN: 978-0262525671)
2. Bruno Munari, "Design As Art", *Penguin UK*, 2009 (ISBN: 978-0141035819)
3. Tom Kelly, Jonathan Littman, "The Art of Innovation", HarperCollins Business, 2002 (ISBN: 978-0007102938)
4. Thomas Lockwood, "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", *Allworth Press*, 2009 (ISBN: 978-1581156683)

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. II Semester – Common to CE, ME, CSE, IT & AE	L	T/P/D	C
	3	1	4

(18BS1MT02) LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS

COURSE PREREQUISITES: Matrices, Differentiation and Integration

COURSE OBJECTIVES: To learn
- Concept of Rank of the matrix and its application to consistency of system of linear equations
- Concept of Eigen Values and Eigen Vectors.
- Nature of Quadratic forms.
- The methods of solving first order differential equations and learn about its applications to basic engineering problems.
- The methods of solving higher order differential equations and learn about its applications to basic engineering problems.

COURSE OUTCOMES: Students will be able to
CO-1: Find the rank of a matrix and to analyze the solution of system of linear equations.
CO-2: Calculate Eigen values and Eigen vectors.
CO-3: Reduce the quadratic form to canonical form.
CO-4: Formulate and solve the problems of first and higher order differential equations.
CO-5: Apply knowledge of differential equations to real world problems.

UNIT-I: Linear Algebra-Matrices
Rank of a matrix by Echelon form and Normal form, Inverse of Non-singular matrices by Gauss-Jordan method; System of linear equations; Consistency of Homogeneous and Non-Homogeneous equations, Gauss Jacobi and Seidel Iteration Method.

UNIT-II: Linear Algebra-Eigen values and Eigen vectors
Eigen values and eigenvectors and their properties, Diagonalization of matrices; Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem

UNIT-III: Real & Complex Matrices, Quadratic forms
Types of Matrices, Symmetric; Hermitian; Skew-Symmetric; Skew-Hermitian; orthogonal matrices; Unitary Matrices and its properties; Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms using Linear Transformation and Orthogonal Transformations.

UNIT-IV: First Order and First Degree ODE
Differential equations of first order and first degree - Exact differential equation , Linear and Bernoulli differential equation , Applications of differential equations of first order and first degree - Newton's law of cooling, Law of natural growth and decay, Orthogonal trajectories.

UNIT-V: Higher Order ODE with constants Coefficients
Second order linear differential equations with constant coefficients: Solution of Homogenous non homogeneous differential equations, Non-Homogeneous terms of the type e , sin (ax), cos (ax), polynomials in x, e V(x), x V(x).

UNIT-VI: Ordinary Differential Equations with Variable Coefficients
Method of variation of parameters; Equations reducible to linear ODE with constant Coefficients: Legendre's equation, Cauchy-Euler equation. Series solutions of second order Ordinary Differential Equations, Singular point, Regular singular point, Frobineous Method.

TEXT BOOKS:
1.   Linear algebra: A modern introduction- D. Poole, 2nd edition; Brooks/Cole-2005
2.   Advanced Engineering Mathematics-Erwin Kreyszig, 9th edition; Publisher: John Wiley-2006.
3.   Higher Engineering Mathematics –B.V. Ramana; Publisher: Tata McGraw Hill, New Delhi, 11th Reprint-2010.

REFERENCES:
1.   Higher Engineering Mathematics-B.S. Grewal, Khanna publishers, 36th Edition-2010.
2.   Differential Equations - S.L. Ross, 3rd Edition, Wiley India-1984.
3.   Advanced Engineering Mathematics - Peter 'O' Neil, publisher: Cengage Learning.
4.   Advanced Engineering Mathematics - R.K. Jain and S.R.K. Iyengar; Narosa Publications.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

	L	T/P/D	C
B.Tech. II Semester – Common to all branches	**3**	**1**	**4**

(18BS1CH01) ENGINEERING CHEMISTRY

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- List out the importance of polymers, surfactants and lubricants in real world scenario.
- Outline the features of conventional and non-conventional sources of energy.
- Discuss the problems of corrosion on structures to interpret the need of alloys and describe the thermodynamic equilibrium of a system using phase rule.
- Emphasize the importance of nanomaterials, analytical techniques, environmental and green chemistry.

COURSE OUTCOMES: After the completion of the course, student will be able to:
CO-1: Identify & recognize the role of polymers, surfactants and lubricants in various fields.
CO-2: Rationalize ideas about alternate sources of energy so as to reduce load on fossil fuels.
CO-3: Summarise the effects of corrosion to indicate the use of alloys and predict the behaviour of a system under different variables.
CO-4: Familiarize with the role of nanomaterials, environmental & green chemistry and assess the use of analytical techniques.

UNIT-I: Polymers
Polymers-Definition, types of polymerization-addition, condensation and copolymerization, Properties of polymers- crystallinity, melting point and glass transition, viscoelasticity, solubility of polymers. Fabrication of polymers (compression, extrusion, blowing and thermoforming). Synthesis, properties and uses of PET, PTFE, PMMA, polycarbonate, Bakelite and urea formaldehyde. Conducting polymers-definition, classification and applications, Dendrimers-definition, features, applications. FRPs and their applications.

UNIT-II: Surfactants and Lubricants
Surfactants: Types of surfactants, cleaning mechanism, hydrophobic and hydrophilic interactions, micelles, reverse micelles and critical micelle concentration. Detergents and their role as cleaning agents.
Lubricants-Definition, types, mechanism of lubrication-thick film lubrication, thin film lubrication and extreme pressure lubrication. Additives and selection of lubricants. Properties-viscosity, cloud and pour point, flash and fire point, saponification number-definition and significance.

UNIT-III: Energy Science
Fuels: Definition, classification, characteristics of a good fuel. Coal-proximate & ultimate analysis-significance. Petroleum- refining, knocking, octane number, cetane number.

Cracking-definition, types of cracking, fluid-bed cracking. Limitations of fossil fuels. Alternative and non-conventional sources of energy – solar, wind, geothermal, nuclear and biomass (advantages and disadvantages).

Battery Technology: Features of batteries, Rechargeable batteries- lithium ion and Zn-air batteries. Fuel cells-methanol-oxygen fuel cell, Solar cells- principle and applications.

UNIT-IV: Alloys and Corrosion

Alloys: Purpose of making alloys, classification of alloys, ferrous alloys ex: Steel, non-ferrous alloys ex: Cu, Al, Pb (features and applications).

Phase rule, definition of terms in phase rule, advantages and limitations of phase rule, simple phase diagram -water system.

Corrosion: Introduction, causes and effects of corrosion, chemical and electrochemical corrosion and mechanism of corrosion. Types-differential aeration corrosion (Pitting and waterline corrosion), differential metal corrosion (Galvanic corrosion). Factors affecting corrosion-nature of metal (position, passivity, purity, areas of anode and cathode) & nature of environment (temperature, pH, humidity). Corrosion control methods-proper designing, cathodic protection, differences between galvanizing and tinning, paints-constituents and functions.

UNIT-V: Nanomaterials and Analytical Techniques

Nanomaterials: Definition, synthesis-top down and bottom up approaches. Properties and application of fullerenes, fullerols and carbon nanotubes. Applications of nanomaterials in electronics, catalysis, telecommunication and medicine.

Analytical Techniques: Working principle and applications of pH-metry, conductometry, colorimetry, chromatography (TLC), Scanning tunneling microscope and atomic force microscope. Sensors: Lab-on-a-chip- features and applications.

UNIT-VI: Environmental and Green Chemistry

Air, water and noise pollution: sources and effects, optimum levels of pollution. Solid waste management and e-waste: effects and management.

Green Chemistry- Definition, principles and applications of green chemistry. Self-healing materials-principle and applications.

TEXT BOOKS:
1. Engineering Chemistry, by P. C Jain and M. Jain, Dhanpat Rai Publications, New Delhi, 16th Edition.
2. Engineering Chemistry, by Prasanta Rath, B. Rama Devi, Ch. Venkata Ramana Reddy, Subhendu Chakroborty, Cengage Publications, Delhi- 2018.
3. A Textbook of Engineering Chemistry by Shashi Chawla, Dhanpat Rai Publications, New Delhi.

REFERENCES:
1. Engineering Chemistry, by S. S. Dara, S. Chand & Company Ltd, New Delhi.
2. Engineering Chemistry by O.G. Palanna, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
3. Engineering Chemistry by B. Sivasankar, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
4. Introduction to Nanoscience, by S. M. Lindsay.

5. Introduction to Environmental Science, by Y. Anjaneyulu, BS Publications, Hyderabad.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. II Semester – Common to CE, ME & AE	L	T/P/D	C
	3	1	4

(18ES1ME01) ENGINEERING MECHANICS

COURSE PREREQUISITES: Mathematics, Physics.

COURSE OBJECTIVES:
- To understand, analyze the forces and moment systems for equilibrium
- To know the concept of centroid and area moment of inertia about any axes
- To distinguish between statics and dynamics & kinematics and kinetics
- To understand the work-energy principle and impulse-momentum principles

COURSE OUTCOMES:

After the completion of the course the student should be able to

CO-1: Analyze the systems using equilibrium conditions and apply the concepts of mechanics to engineering applications

CO-2: Determine the centroid of composite areas and moment of inertia of areas

CO-3: Solve the kinematics and kinetics problems.

CO-4: Apply work-energy principle, impulse-momentum principle to solve engineering problems

UNIT-I:

Forces:

Introduction to Engineering Mechanics – Basic concepts - Classification of a force system - Parallelogram law of forces - Triangle law of forces - Polygon law of forces – Law of transmissibility of forces – Principle of superposition - Lami's theorem - Free Body Diagram – Resultant – Equilibrant - Resultant of coplanar concurrent forces.

Moments:

Moment of a force - Varignon's principle - Parallel forces - Resultant of parallel forces – Couple - Moment of a couple about any point lying in the plane - Resolution of a force into a force-couple and vice-versa - Resultant of coplanar non-concurrent forces.

UNIT-II:

Friction:

Types of Friction - Limiting friction - Laws of friction - Equilibrium of bodies on rough horizontal and inclined planes - Equilibrium of connected bodies on rough horizontal and inclined planes.

UNIT-III:
Centroid & Centre of Gravity:
Introduction - Centroid - Centroids of lines, Standard areas and volumes – Centroids of composite sections - Centre of gravity of bodies - Pappu's theorems.

UNIT-IV:
Area Moment of Inertia:
Introduction - Inertia - Inertia of areas - Rotation of areas - Radius of gyration - Polar moment of inertia - Parallel axis theorem - Perpendicular axis theorem - Moments of inertia of standard sections and composite sections.

UNIT-V:
Kinematics of Particles:
Kinematics of particles – Rectilinear motion – Curvilinear motion – Projectiles.
Kinetics of Particles:
Kinetics of particles – Newton's Second Law – Differential equations of rectilinear and curvilinear motion – Dynamic equilibrium – Inertia force – D Alembert's Principle applied for rectilinear and curvilinear motion.

UNIT-VI:
Work–Energy, Impulse–Momentum:
Work of a force - Principle of Work and Energy - Application of principle of Work-Energy - Impulse-Momentum Principle, Application of Impulse-Momentum principle.

TEXT BOOKS:
1.   Engineering Mechanics by S. Timoshenko, D. H. Young & J. V. Rao, TMH Publishers.
2.   Singer's Engineering Mechanics by K. Vijaya Kumar Reddy & J. Suresh Kumar, B.S Publishers.

REFERENCES:
1.   Engineering Mechanics by J. L. Meriam & L.G. Kraige, Wiley Publishers.
2.   Engineering Mechanics by R. C. Hibbeler, Pearson Education.
3.   Engineering Mechanics by A.K. Tayal, Umesh Publications.
4.   Engineering Mechanics by R. K. Rajput, Laxmi Publications.
5.   A Text Book of Engineering Mechanics by R. K. Bansal, Laxmi Publications.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. II Semester – Common to all branches	L	T/P/D	C
	2	0	2

(18HS1EN01) ENGLISH

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- Enhance their vocabulary through the use of affixes/stem and learn technical vocabulary in specialist fields.
- Read and comprehend different kinds of texts (tone, tenor, sound, sense, diction, etc.- sub-skills)
- Write clear, concise, and correct sentences and paragraphs to produce appropriate technical prose
- Recognize and practice use the rhetorical elements necessary for the successful practice of scientific and technical communication

COURSE OUTCOMES: On completion of the course, the student will be able to
CO-1: Use vocabulary effectively and contextually.
CO-2: Employ reading skills to comprehend different kinds of texts. (tone, tenor, sound, sense, diction, etc.- sub-skills)
CO-3: Apply principles of critical thinking, problem solving, for clarity, conciseness and accuracy of expression in academic and professional communication
CO-4: Demonstrate improved competence in Standard Written English, including grammar, sentence and paragraph structure, coherence, and use this knowledge to accurately communicate technical information.
CO-5: Employ the appropriate rhetorical patterns of discourse in technical and business contexts for scientific and technical communication

UNIT-I:
1. Reading: On the Conduct of Life by William Hazlitt
2. Speaking & Listening: Pronunciation, Stress, Intonation and Rhythm
3. Grammar: Prepositions
4. Vocabulary: Word Formation- I
5. Writing: Punctuation, Clauses and Sentences
6. Life Skills: Values and Ethics; 'If' by Rudyard Kipling

UNIT-II:
1. Reading: The Brook by Alfred Tennyson
2. Speaking & Listening: Introducing oneself and others, making announcements
3. Grammar: Articles
4. Vocabulary: Word Formation- II
5. Writing: Principles of Good Writing-Coherence, Cohesion
6. Life Skills: Self Improvement; How I Became a Public

Speaker by G.B. Shaw

UNIT-III:
1. Reading: The Death Trap by Saki
2. Speaking & Listening: Gaining attention, Interrupting Conversations
3. Grammar: Noun-Pronoun Agreement; Subject-Verb Agreement
4. Vocabulary: Word Formation- III
5. Writing: Transitional Devices & Paragraph Writing; Writing Process
6. Life Skills: Time Management; On Saving Time by Seneca

UNIT-IV:
1. Reading: Chindu Yellamma
2. Speaking & Listening: Making Requests and Responding to them; Extended Listening
3. Grammar: Misplaced Modifiers
4. Vocabulary: Synonyms and Antonyms
5. Writing: Writing a Summary
6. Life Skills: Innovation; Muhammad Yunus

UNIT-V:
1. Reading: Politics and the English Language by George Orwell
2. Speaking & Listening: Interview Skills; Making a Presentation
3. Grammar: Cliches; Redundancies
4. Vocabulary: Common Abbreviations
5. Writing: Cause and Effect Paragraphs
6. Life Skills: Motivation; The Dancer with a White Parasol by Ranjana Dave

UNIT-VI:
Organizational Patterns for writing
1. Patterns of Writing: Comparison and Contrast
2. Patterns of Writing : Classification Paragraph
3. Patterns of Writing: Problem-Solution Pattern of writing

TEXT BOOK:
1. Language and Life : A Skills Approach   by Orient Black Swan

RECOMMENDED BOOKS:
1. Technical Communication, Meenakshi Raman & Sangeeta Sharma, Oxford University Press
2. Effective Communication Skills, Kulbushan Kumar, Khanna Publishing House, Delhi
3. Communication Skills, Pushplata, Sanjay Kumar, Oxford University Press
4. Longman Dictionary of Common Errors by N.D. Turton and J.B. Heaton

SUGGESTED READINGS:

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
7. Rhetorical Grammar: Grammatical Choices, Rhetorical Effects (7th ed.), Martha Kolln & Loretta Gray. New York: Longman, 2012. ISBN-10: 0321846729; ISBN-13: 978-0321846723
8. Longman Dictionary of Common Errors.(Nigel D. Turton & J. B. Heaten)

B.Tech. II Semester – Common to all branches

L	T/P/D	C
0	2	1

(18HS2EN01) ENGLISH LANGUAGE COMMUNICATION SKILLS LABORATORY

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
● Provide ample practice in LSRW skills and train the students in oral presentations, public speaking, role play and situational dialogue.
● Provide practice in vocabulary usage, grammatical construction, structural patterns, and improve comprehension abilities in the students.
● Train students to use neutral accent through phonetic sounds, symbols, stress and intonation.
● Enable students to transfer information from verbal to graphic representation and vice versa.
● Equip the learners to learn basic vocabulary of 3000 words. (as identified in Oxford or Cambridge dictionary).

COURSE OUTCOMES: After going through this course, the student will be able to
CO-1: Comprehend spoken and written discourse.
CO-2: Speak fluently with neutral accent and exhibit interpersonal skills.
CO-3: Write accurately, coherently and lucidly making appropriate use of words depending on context.
CO-4: Introduce oneself to people and be able to speak extempore.
CO-5: Should have learnt the basic vocabulary of 3000 words. (as identified by oxford/Cambridge advanced learners dictionary).

UNIT-I:
1. Introduction of Self and others
2. Listening Comprehension-Listening for details
3. Reading Skills- Skimming and Scanning

UNIT-II:
1. Role play-
   i)   Expressing likes and dislikes;
   ii)   Agreeing and disagreeing
   iii)   Making requests (Using modals for polite requests)
   iv)   Accepting and declining requests
2. Listening and note taking
3. Reading Skills - Intensive Reading and Extensive Reading

UNIT-III:
1. Extempore Speech : JAM
2. Accuracy in listening- listening to discussion on specific issues

3. Pronunciation, Intonation, Stress and Rhythm

UNIT-IV:
1. Speaking Activity: Oral Presentation
2. Accuracy in listening- listening to discussion on specific issues
3. Reading Comprehension

UNIT-V:
1. Speaking Activity: Book/Film Review
2. Reading Comprehension-Contextual Vocabulary
3. Passive Voice-Constructing the impersonal passive

UNIT-VI:
1. Writing Skills: Information Transfer
2. Definition of a Technical Term
3. Description of a Mechanism/Process

SUGGESTED READINGS:
1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.
4. Cambridge or Oxford Dictionary.
5. Fowler's Modern English Usage-Revised by R.W. Burchfield

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. II Semester – Common to all branches	L	T/P/D	C
	0	3	1.5

(18BS2CH01) ENGINEERING CHEMISTRY LABORATORY

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- To practically learn the preparation of standard solutions and estimate hardness & chloride content so as to check its suitability for various purposes.
- To determine the rate constant of a reaction and check the variation of concentrations with respect to time.
- To measure properties like adsorption, absorption of light, conductance, viscosity, pH and surface tension.
- To synthesize a polymer and to separate a mixture of organic compounds by Thin Layer Chromatographic (TLC) technique.

COURSE OUTCOMES: The students will gain skills
CO-1: To record the amount of hardness and chloride content in water and interpret the significance of its presence in water.
CO-2: To analyze the influence of variation of concentration with time on rate constant.
CO-3: To report and predict the significance of properties like absorption of light, adsorption, conductance, viscosity, pH and surface tension.
CO-4: To demonstrate the technique of Thin Layer Chromatographic (TLC) and preparation of a polymer.

LIST OF EXPERIMENTS:
1. Estimation of hardness of water by complexometric method using EDTA.
2. Determination of chloride content in the given sample water using Argentometric method.
3. Determination of the rate constant of hydrolysis of ester.
4. Verification of Freundlich/Langmuir isotherm for adsorption of acetic acid on charcoal.
5. Estimation of copper present in the given solution by colorimetric method.
6. Conductometric titration of Acid vs Base.
7. Determination of viscosity of sample oil by Redwood Viscometer-I.
8. Determination of pH of various sample solutions by pH meter.
9. Determination of R_f value of organic compounds in a mixture by Thin Layer Chromatography.
10. Determination of surface tension of a liquid by drop method using Stalagmometer.
11. Titration of Acid vs Base using pH metric method.
12. Synthesis of a Polymer-Bakelite/Nylon.

TEXT BOOKS:
1. Laboratory Manual on Engineering Chemistry by S.K. Bhasin and Sudha Rani; Dhanpat Rai Publications.
2. College Practical Chemistry V.K. Ahluwalia, Sunitha Dhingra, Adargh Gulati, University Press Pvt. Ltd.
3. Practical chemistry by Dr. O. P. Pandey, D.N. Bajpai, and Dr. S. Giri; S. Chand Publications.

REFERENCES:
1. Vogel's Text book of Quantitative Chemical Analysis by G.N. Jeffery, J. Bassett, J. Mendham and R.C. Denny, Longmann, ELBS.
2. Advanced Practical Physical Chemistry by J.D. Yadav, Goel Publishing House.
3. Practical Physical Chemistry by B.D. Khosla, R. Chand and Sons.

VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

B.Tech. II Semester – Common to all branches	L	T/P/D	C
	1	3	2.5

(18ES2ME01) WORKSHOP PRACTICES

COURSE PREREQUISITES: None

COURSE OBJECTIVES:
- To know the different popular manufacturing process.
- To gain a good basic working knowledge required for the production of various engineering products.
- To provide hands on experience about use of different engineering materials, tools, equipments and processes those are common in the engineering field.
- To identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances.

COURSE OUTCOMES: After completion of the course, the student is able to:
CO-1: Exposure to Various types of manufacturing Process.
CO-2: Fabricate/make components from wood, MS flat, GI Sheet etc. – hands on experience.
CO-3: Exposure to manufacturing of machine components like fasteners, holes & threaded holes etc.
CO-4: Produce small devices / products /appliances by assembling different components.

Lectures & Videos:
1. Manufacturing Methods - Casting, Forming, Machining, Joining, Advanced Manufacturing Methods
2. CNC Machining, Additive Manufacturing
3. Fitting Operations & Power Tools
4. Electrical & Electronics
5. Carpentry
6. Plastic Moulding, Glass Cutting
7. Metal Casting
8. Welding (Arc Welding & Gas Welding), Brazing
9. Power Tools
10. Printed Circuit Boards

I. Carpentry
  i.   Cross lap joint
  ii.   Mortise & tenon joint

II. Fitting
  i.   Square fitting
  ii.   L-Fitting

III. Welding
  i.   Butt joint by arc welding
  ii.   Lap joint by arc welding

IV. Smithy
  i.   Making of Rectangular Tray from sheet metal.
  ii.   Making of U shaped component by black smithy

V. Electrical & Electronics
  i.   Single lamp connection & Stair case connection
  ii.   Translation of any tested / designed and tested circuits on a PCB.

VI. Machine Shop
  i.   Step turning on lathe
  ii.   Drilling & threading

TEXT BOOKS:
1. Workshop Manual by P. Kannaiah and K.L. Narayana; Publisher: Scitech.
2. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., ―Elements of Workshop Technology‖, Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3. Printed Circuit Boards: Design, Fabrication, and Assembly by R. S. Khandpur (McGraw-Hill Electronic Engineering)

REFERENCES:
1. Kalpakjian S. And Steven S. Schmid, ―Manufacturing Engineering and Technology‖, 4th edition, Pearson Education India Edition, 2002.
2. Gowri P. Hariharan and A. Suresh Babu, Manufacturing Technology – I‖ Pearson Education, 2008.
3. Roy A. Lindberg, ―Processes and Materials of Manufacture‖, 4th edition, Prentice Hall India, 1998.
4. Rao P.N., ― Manufacturing Technology‖, Vol. I and Vol. II, Tata McGraw Hill House, 2017.