MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB

(Formerly West Bengal University of Technology)

Syllabus for B. Sc. In Robotics& 3D Printing (In-house)
(Effective for Students Admitted in Academic Session 2020-2021)
In CBCS Format

CURRICULUM STRUCTURE

1st Semester

Subject Type			Course Code	Course Name	Credit Points	Credit Distribution			Mode of Delivery		
						Th	Pr	Tu	Offline	Online	Blended
Core course	CC1	CC 1.1	RBEE101	Basic Electrical Engineering	4	4	0	0	✓	✓	✓
		CC1.2	RBEE191	Basic Electrical Engineering Lab	2	0	2	0	✓	✓	✓
	CC2	CC2.1	RBMS101	Engineering Mechanics	4	4	0	0	✓	✓	✓
		CC2.2	RBMS191	Engineering Graphics	2	0	2	0	✓	✓	✓
GE		GE1.1	RBM101	Engineering Mathematics I	4	4	0	0	✓	✓	✓
		GE1.2	RBMT101	Engineering Mathematics I Tutorial	2	0	0	2	✓	✓	✓
AECC		AECC 1	RBHS101	Communicative English	2	2	0	0	✓	✓	✓
	Semester Credits				**20**						

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Semester-I

DETAILED SYLLABUS

Paper Name: Basic Electrical Engineering
Code: RB-EE 101
Contact: 3L+1T
Credits: 4
Allotted Hrs: 36

Aim:
Basic electrical engineering is an introductory course in electrical engineering. Students are introduced to simple applied electrical circuits, theories and practice to impart skill set to have visualization of electrical engineering applications. It is a course suitable for students pursuing electrical engineering as well as other related engineering disciplines.

Course Objective:
The course objectives are:
1. Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
2. Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
3. Explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
4. Identification the importance of transformers in transmission and distribution of electric power.
5. Explain basic knowledge of LT Switch Gears, Circuit Breakers and Earthing for domestic application.
6. Give basic idea of Power converters and their applications.

Detailed contents

Module 1: DC Circuits (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours)

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters (6 hours)

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module 6: Electrical Installations (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Text / Reference Books

(i) D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
(ii) D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
(iii)L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
(iv)E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
(v) V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Outcomes:

On completion of the course, student will able to-
1. Classify of Electrical Elements and Energy Sources.
2. Solve simple DC Circuits and Network Theorems.
3. Analyze RLC Combination in Time Domain.
4. Specify a Sinusoidal Waveform with drawing phasor diagram.
5. Classify Power and determine Power Factor.
6. Solve AC RLC Series-Parallel Combination problems.
7. Analyse Three Phase balanced circuits.
8. Specify in detail ideal and practical transformers.
9. Calculate parameters of transformers.
10. Performance and application of Autotransformer and three phase connections.

11. Concept of generation of magnetic field.
12. Calculate parameters of Three Phase Induction Motor and analyze performance.
13. Calculate parameters of Single Phase Induction Motor and analyze performance.
14. Calculate parameters of Separately Exited DC Motor and analyze performance.
15. Calculate parameters of Synchronous Generator and analyze performance.
16. Classify Power Converters and analyze performance of power converter.
17. Identification of LT Switchgear, Circuit Breaker and Earthing and their application.
18. Identify Wires and Cables.
19. Calculate parameters of Battery and its performance analysis.

(ii)**Basic Electrical Engineering Laboratory [L : 0; T:0 ; P : 2 (2 credit)]**

List of experiments/demonstrations:

- Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
- Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
- Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
- Torque Speed Characteristic of separately excited dc motor.
- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at supersynchronous speed.
- Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
- Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

Laboratory Outcomes:

On completion of the course, student will able to-

1. Identify and use Electrical Elements and Measuring Instruments.
2. Measure Time Response of RLC Circuits and Resonance.
3. Analyse performance of Single Phase Transformer.
4. Analyse performance of Three Phase Transformer.
5. Identify parts of DC Machines, Induction Machine, Synchronous Machine, Single Phase Induction Machine.
6. Analyse performance of Induction Motor.
7. Analyse performance of DC Motor.
8. Identify LT Switchgears.

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Paper Name: Engineering Mechanics
Code: RBMS 101
Contact hours/week: 3L+1T
Credits: 4

Aim: Engineering Mechanics is an introductory course in Robotics & 3D Printing. The topics introduced will serve as basic tools for specialized studies in many fields of Robotics and 3D Printing.

COURSE OBJECTIVE:

- To introduce the basic principles of engineering mechanics with emphasis on their analysis and application to practical engineering problems
- To determine the representation of forces and moments
- To describe static equilibrium of particles and rigid bodies
- To comprehend the effect of Friction on general plane motion
- To analyse the properties of surfaces & solids in relation to moment of inertia
- To illustrate the laws of motion, kinematics of motion and their interrelationship

UNIT I STATICS OF PARTICLES 9+6

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 9+6

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9+6

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 9+6

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND RIGID BODY DYNAMICS

9+6

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Course Outcome (CO) For Engineering Mechanics: -

On completion of the course, student will able to-

CO1: Draw free body diagrams and determine the resultant of forces and/or moments.

CO2: Analyse the rigid body in equilibrium.

CO3: Determine the centroid and second moment of area of sections.

CO4: Apply laws of mechanics to determine efficiency of simple machines with consideration of friction.

CO5: Analyse the motion and calculate trajectory characteristics.

CO6: Determine the friction force and the effects by the use of laws of friction, also determine the Rolling resistance and Translation and Rotation of the Rigid Bodies.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

REFERENCES:

1. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
2. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
3. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
4. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
5. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

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Paper Name: Engineering Graphics
Code: RB-MS191
Contact Hours/Week: 3P
Credits: 2

OBJECTIVES:

1.To present fundamentals of graphics and drafting appropriate for developing functional skill in computer aided drafting.

2. To provide students with adequate knowledge and experience in preparing engineering drawings using AutoCAD

3. To teach students to read, construct and understand basic engineering drawings.

4. To help students acquire the skills pertinent to the production of properly detailed, formatted and dimensioned Engineering drawings.

Sl. No.	Content	Lecture (L)	Practical (P)
1	**INTRODUCTION TO ENGINEERING DRAWING** Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.	1	4
2	**LETTERING, DIMENSIONING, SCALES** Plain scale, Diagonal scale and Vernier Scales.	1	4
3	**GEOMETRICAL CONSTRUCTION AND CURVES** Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archemedian Spiral.	1	4
4	**PROJECTION OF POINTS, LINES, SURFACES** Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes- Auxiliary Planes.	1	4
5	**PROJECTION OF REGULAR SOLIDS** Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).	1	4

6	**COMBINATION OF REGULAR SOLIDS, FLOOR PLANS** Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.	1	4
7	**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;	1	4
8	**SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS** Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)	1	4
9	**OVERVIEW OF COMPUTER GRAPHICS**, C**USTOMISATION& CAD DRAWING** listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: 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 (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; 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;	1	4

10	**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 command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer- aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;	2	8
11	**DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT** Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid- modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).	2	8

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Course Outcomes

On completion of the course, student will able to-

CO1: Familiarize with the fundamentals and standards of Engineering graphics

CO2: perform freehand sketching of basic geometrical constructions and multiple views of objects.

CO3: Project orthographic projections of lines and plane surfaces.

CO4: Draw projections and solids and development of surfaces.

CO5: visualize and to project isometric and perspective sections of simple solids.

CO6: Ability to visualize the pictorial view and draw orthographic projection on reference planes including sections by using AutoCAD.

CO7: Ability to draw 2D & 3D Object in Auto CAD.

General Instructions

1. In every topic some problems are to be done in the class and some are to be given to students as home assignment.
2. The problems for class work are to be prepared on drawing sheet of A1 size in the class/ using AutoCAD software.
3. The problems for home assignments are to be prepared on drawing copy/ using AutoCAD software.
4. Print out of every assignment is to be taken for CAD Drawings on Drawing sheets (A4 Sheets).
5. A title block must be prepared in each sheet/ assignment.

Following is the list of drawing instruments that required for making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter/ Set-squares (45°–45° & 60°–90°), T-square 3. Protractor (180°, 360°)
4. Scales (Plain, Diagonal)
5. Compass (Small and Large)
6. Divider (Small and Large)
7. French Curves
8. Drawing paper (A1 Size)
9. Drawing pencil (H, HB, B)
10. Sharpener
11. Eraser
12. Drawing pins & clips
13. Duster or handkerchief etc.

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Communicative English
Code: RB-HU 101
Contact: 3L
Credits: 2
Allotted Hrs: 36

COURSE OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

Detailed contents

Unit I: Grammar: Correction of sentence, Vocabulary / word formation, Single word for a group of words, Fill in the blank, transformation of sentences, Structure of sentences – Active / Passive Voice – Direct / Indirect Narration

Unit II: Essay – Descriptive – Comparative – Argumentative – Thesis statement- Structure of opening / concluding paragraphs – Body of the essay

Unit III: Reading Comprehension – Global – Contextual – Inferential – Select passages from recommended text

Unit IV: Business Correspondence – Letter Writing – Formal.Drafting.Biodata- Resume′- Curriculum Vitae

Unit V: Report Writing – Structure , Types of report – Practice Writing

Unit VI: Communication / Public Speaking skills , Features of effective speech, verbal-nonverbal ,Department of Information Technology

Unit VII: Group discussion – principle – practice

Course Outcomes:

On completion of the course, student will able to

CO1: Comprehend conversations and short talks delivered in English

CO2: Write short essays of a general kind and personal letters and emails in English

CO3: Prepare technical reports and short essays.

CO4: Student will able to Learn basic do's and don'ts of an interview.

CO5: student will able to speak in English.

Reference Books:

1. Mark MaCormack : "Communication"
2. John Metchell" How to write reports"
3. S R Inthira& V Saraswathi" Enrich your English – a) Communication skills b) Academic
skills " Publisher CIEFL & OUP
4. R.C. Sharma and K.Mohan , "Business Correspondence and Report Writing " , Tata McGraw Hill , New Delhi , 1994
5. L.Gartside , "Model Business Letters" , Pitman , London , 1992
6. Longman , "Longman Dictionary of Contemporary English" (or 'Oxford Advanced Learner's Dictionary of Current English' , OUP , 1998.
7. Maxwell Nurnberg and RosenblumMorris , "All About Words" , General Book Depot, New Delhi , 1995
8. A Text Book for English foe Engineers & Technologists

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ENGINEERING MATHEMATICS I

Code:RB-M 101
Contact: 3L+1T
Credits: 4
Allotted Hrs: 36

Aim: The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective realization of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Course Objectives:

Course objectives are:
1. To provide knowledge of basic operations of modern algebra and group theory
2. To teach students solving problems involving trigonometric functions
3. Imparting concepts of limit, continuity and differentiability of various functions
4. To teach students solving higher order differentiation
5. Giving knowledge of integration and its applications to find area and volume
6. Imparting knowledge for generating and solving differential equations for practical problems
7. Teaching students concept of imaginary numbers and gives awareness about algebra of complex numbers which helps in understanding of engineering subjects like electrical circuits, Electromagnetic wave theory, and complex analysis etc.
8. To provide knowledge of matrices which is applied for solving system of linear equations and useful in various fields of technology
9. helping students to understand and apply the concept of indeterminate conditions, expansion of standard and non-standard functions in series form
10. To provide the knowledge of probability theories for solving day-to-day problems
11. To teach students various statistical methods for analyzing datasets in the area of engineering and technology

Detailed contents

UNIT I: Modern algebra Binary Operation; Addition Modulo n; Multiplication modulo n; semi group; properties of groups; subgroup.

UNIT II: Trigonometry Radian or circular Measure; Trigonometric Functions; Trigonometric ratios of angle θ when θ is acute; trigonometric ratios of certain standard angles; allied angles; compound angles; multiple and sub- multiple angles.

UNIT III: Limits and Continuity The real number system; The concept of limit; concept of continuity.

UNIT IV: Differentiation Differentiation of powers of x; Differentiation of ex and log x; differentiation of trigonometric functions; Rules for finding derivatives; Different types of differentiation; logarithmic differentiation; differentiation by substitution; differentiation of implicit functions; differentiation from parametric equation. Differentiation from first principles.

UNIT V: Integrations Integration of standard Functions; rules of Integration; More formulas in integration; Definite integrals.

UNIT VI: Differential equations First order differential equations; practical approach to Differential equations; first order and first degree differential equations; homogeneous equations. Linear equations; Bernoulli's equation; Exact Differential Equations.

UNIT VII: Complex Numbers Complex Numbers; Conjugate of a complex number; modulus of a complex Number; geometrical representation of complex number; De Moivere's theorem; nth roots of a complex number.

UNIT VIII: Matrices and Determinants Definition of a matrix; Operations on matrices; Square Matrix and its inverse; determinants; properties of determinants; the inverse of a matrix; solution of equations using matrices and determinants; solving equations using determinants.

UNIT IX: Infinite Series Convergence and divergence; series of positive terms; binomial series; exponential series; logarithmic series.

UNIT X: Probability Concept of probability; sample space and events; three approaches of probability; kolmogorov's axiomatic approach to probability; conditional probability and independence of events; bay's theorem.

UNIT XI: Basics Statistics Measures of central Tendency; Standard Deviation; Discrete series. Methods; Deviation taken from assumed mean; continuous series; combined standard deviation; coefficient of variation; variance.

Course Outcomes:

On completion of the course, student will able to-
CO1: solve problems related to modern algebra and group theory
CO2: apply calculus to solve various engineering problems
CO3: solve practical problems involving differential equations
CO4: solve various problems in the field of engineering and technology using the concepts of Matrices and Determinants
CO5: find the value of Finite and infinite series and use the Binomial formulae for solving complex algebraic equations
CO6: use the concepts and theories of probability in day-to-day problems
CO7: perform statistical analysis of various datasets in the area of engineering and Technology

Reference Books:

1. Banerjee A., De S.K. and Sen S.: Mathematical Probability, U.N. Dhur& Sons.
2. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

Learning Resources:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. Corresponding set of CAD Software Theory and User Manuals