



DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT
Scheme & Syllabus for UG programme – III & IV Semesters

Department Vision

To emerge as an excellent center for imparting quality higher education and generating highly proficient technical manpower to adopt to the constantly changing global scenario with professional and ethical values.

Department Mission

- Providing excellent education in curricular, co- curricular and extra-curricular activities to students.
- Facilitating to continue their education through research activities
- Catering to the needs of the Industry and society.
- Nurturing and mentoring students to acceptance by stake holders

Program Outcomes (POs)

PO 1	An ability to apply knowledge of science, computing, mathematics, and industrial engineering fundamentals appropriate to the discipline.
PO 2	An ability to analyze a problem, and identify and formulate the industrial engineering principles appropriate to its solution
PO 3	An ability to design, implement, and evaluate a computer-based industrial engineering system or/and process to meet desired needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations
PO 4	An ability to design and conduct experiments using IE models and IT tools , to analyze and interpret data leading to feasible solutions
PO 5	An ability to use current techniques, modern tools and skills necessary for industrial engineering practice
PO 6	An ability to analyze the local and global impact of industrial engineering solutions on individuals, organizations, and society
PO 7	Develop a Knowledge of contemporary issues and solutions
PO 8	Develop an understanding of security, professional, ethical, legal, and social issues and responsibilities of an industrial engineer
PO 9	An ability to function effectively, individually and in a team, in diverse and multi-disciplinary environments to accomplish a common goal
PO 10	Develop an ability to communicate effectively with a range of audiences in all situations
PO 11	An understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects in a multidisciplinary environment
PO 12	Recognize the need for and an ability to engage in continuing professional development



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NOTATIONS

AY	Academic Year
AAT	Alternative Assessment Tools
BOE	Board of Examiners
BOS	Board of Studies
CBCS	Choice Based Credit System
CGPA	Cumulative Grade Point Averages
CIE	Continuous Internal Evaluation
DC	Departmental Core
GC	Group Core
HSS	Humanity and Social Science Courses
IC	Institutional Core
IE	Institutional Elective
IL	Institutional Lab.
LTPS	Lecture – Tutorial-Practical-Self Study
NFTE	Not Fit for Technical Education
PCC	Professional Core Courses
PEC	Professional Elective Courses
SEE	Semester End Examination
SGPA	Semester Grade Point Average
ST	Studio
SS	Self Study
CO	Course Outcome
PO	Program Outcome
PEO	Program Educational Objectives



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SCHEME OF INSTRUCTIONS FOR THIRD SEMESTER

SINo	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	15MA3DCMIE	HIGHER ENGINEERING MATHEMATICS	3	1	0	0	4
2	15IM3DCPT1	PRODUCTION TECHNOLOGY-I	3	0	1	2	6
3	15IM3DCSOM	STRENGTH OF MATERIALS	3	0	0	0	3
4	15IM3DCMMM	MECHANICAL MEASUREMENTS & METROLOGY	3	0	1	0	4
5	15IM3DCEES	ELEMENTS OF ENERGY SYSTEMS	3	0	0	0	3
6	15IM3GCCMD	COMPUTER AIDED MACHINE DRAWING	1	0	2	2	5
		Total					25

SCHEME OF INSTRUCTIONS FOR FOURTH SEMESTER

SI No	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	15IM4DCIEG	INDUSTRIAL ENGINEERING	3	0	1	2	6
2	15IM4DCSFE	STATISTICS FOR ENGINEERS	3	0	0	0	3
3	15IM4DCMAE	MANAGEMENT AND ENTREPRENEURSHIP	3	0	0	0	3
4	15IM4DCPT2	PRODUCTION TECHNOLOGY-II	3	0	1	2	6
5	15IM4DCMCD	MACHINE DESIGN	3	0	0	0	3
6	15IM4DCMSM	MATERIAL SCIENCE & METALLURGY	3	0	1	0	4
		Total					25



B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
III SEMESTER

Course Name	Higher Engineering Mathematics	Course Code	15MA3DCHEM
Credits	04	L – T –P–S	3-1-0-0

Prerequisites: Matrices, concepts of Trigonometry and Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives, solution methods of ordinary differential equations.

Course Outcomes:

On completion of the course, the student will have the ability to:

- CO 1 Compute solution of a system of algebraic equations
- CO 2 Demonstrate an understanding to Fourier series and Fourier transforms.
- CO 3 Formulate boundary value problems involving one dimensional heat and wave equation.
- CO 4 Employ analytical techniques to solve partial differential equations with appropriate boundary conditions
- CO 5 Apply Z- transforms techniques to solve difference equations
- CO 6 Obtain the extremal of a functional.

UNIT-1

MATRICES

[9 hours]

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of system of linear equations and solution.

Solution of a system of non-homogenous equations: Gauss elimination method, LU decomposition method, Gauss-Seidel method. Eigenvalues and eigenvectors of matrices.

Reduction of a matrix to diagonal form. **(7L + 2T)**

Suggested Reading: Inverse of a matrix using Gauss-Jordan method. Largest eigenvalue and corresponding eigenvector using Rayleigh power method.

UNIT-2

FOURIER SERIES

[9 hours]

Introduction: Periodic function, Dirichlet's conditions, statement of Fourier Theorem, Fourier series of a periodic function of period $2l$, Fourier series of functions having points of discontinuity.

Applications: Fourier series of typical waveforms -saw toothed waveform, triangular waveform, square waveform, half-wave rectifier, full wave rectifier and modified saw tooth waveform. Practical harmonic analysis. (7L + 2T)

Suggested Reading: Half range Fourier series, Fourier series of discrete functions, Complex Fourier series.

UNIT-3

FOURIER TRANSFORMS

[10 hours]

Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms, Fourier transforms of derivatives. (7L + 3T)

Suggested Reading: Convolution theorem, Parseval's identities and physical significance of Parseval's identities.

UNIT-4

PARTIAL DIFFERENTIAL EQUATIONS

[10 hours]

Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions. Equations of first order- The linear equation $Pp + Qq = R$ (Lagrange's partial differential equation).

Applications: One-dimensional heat equation and wave equation (without proof), various possible solutions of these by the method of separation of variables. (7L + 3T)

Suggested Reading: Direct integration method, method of separation of variables, D'Alembert's solution of wave equation.

UNIT-5

Z –TRANSFORMS AND CALCULUS OF VARIATIONS

[10 hours]

Z-transforms: Definition, Properties, Transforms of standard functions, Inverse transforms.

Applications: Solution of difference equations using Z- transforms.

Calculus of variations: Variation of a functional, Euler's equation, variational problems.

Applications: Hanging cable problem, Geodesics on a right circular cylinder, Brachistochrone problem. (8L + 2T)

Suggested Reading: Minimal surface of revolution, Geodesics of a right circular cone and sphere.

Mathematics Lab

- Solution of system of algebraic equations using Gauss Seidel method
- LU decomposition of matrices.
- Eigenvalues and eigenvectors of matrices.
- Largest and smallest eigenvalue and corresponding eigenvector of a matrix.
- Diagonalisation of matrices
- Z-transforms

Bibliography

Text Books

1. “Advanced Engineering Mathematics”, Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley-India.
2. “Advanced Engineering Mathematics”, Dennis G. Zill and Cullen, 4th edition, 2011, Jones and Bartlett India Pvt. Ltd.

Reference Books:

1. “Higher Engineering Mathematics”, B.V. Ramana, 6th edition, 2007, Tata McGraw Hill.
2. “Higher Engineering Mathematics”, B.S. Grewal, 43rd edition, 2013, Khanna Publishers.

E books and online course materials

- (1) Engineering Mathematics, [K. A. Stroud](#), [Dexter J. Booth](#), Industrial Press, 2001
http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
- (2) Advanced Engineering Mathematics, P. V. O’Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

Online Courses and Video Lectures:

- (1) <http://ocw.mit.edu/courses/mathematics/> (online course material)
- (2) <http://nptel.ac.in/courses.php?disciplineId=111>
- (3) <https://www.khanacademy.org/>
- (4) E-learning: www.vtu.ac.in
- (5) <https://www.class-central.com/subject/math> (MOOCS)

On completion of the course students will be able to:

Course Code	CO#	COURSE OUTCOME (CO)	PO	Bloom’s level
	CO 1	Compute solution of a system of algebraic equations.	2, 3	2, 3
	CO 2	Determine whether a given system is stable or unstable.	2, 3	2, 3
	CO 3	Express given functions to form Fourier series.	2, 3, 4	2, 3, 4
	CO 4	Demonstrate an understanding of Fourier transforms techniques	2, 3, 4	2, 3, 4
	CO 5	Employ analytical techniques to solve partial differential equations with appropriate boundary conditions	2, 3, 4	2, 3, 4
	CO 6	Apply Z- transforms techniques to solve difference equations.	2, 3	2, 3
	CO 7	Use calculus of variations to find the extremal of a functional	2, 3	2, 3

Question Paper Pattern

1. Each unit consists of one full question.
2. Each full question consists of three or four subdivisions.
3. Five full questions to be answered.
4. Internal choice in unit-3 and unit-5

Assessment:

- Each unit consists of one full question.
- Each full question consists of three or four subdivisions.
- Five full questions to be answered.
- To set one question from Units 1, 2, 5 and two questions from Unit 3 and Unit 4

Questions for CIE and SEE will be designed to evaluate the various educational components (Blooms taxonomy) such as:

- Remembering and understanding the course contents (weightage: 40%)
- Applying the knowledge acquired from the course (weightage: 35%)
- Analyzing various engineering problems (weightage: 15%)
- Understanding of various system models (weightage: 5%)



B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
III SEMESTER

Course Title	PRODUCTION TECHNOLOGY - I		
Course Code	15IM3DCPT1	L - T – P-S	3 -0- 1-2

PRE-REQUISITES: NIL

Unit- 1

Theory of Metal Cutting:

Single point cutting tool nomenclature, Merchant's circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems of Merchant's analysis, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation, problems on tool life evaluation.

07Hrs.

Cutting tool materials:

Types of cutting tool materials HSS, carbides coated carbides, ceramics

02Hrs.

Cutting fluids:

Desired properties, types and selection, Heat generation in metal cutting, factors affecting heat generation, Heat distribution in tool and W/P, Measurement of tool tip temperature. Desired properties of Cutting tool materials

02Hrs.

Unit-2

Production Lathe: Classification of Lathes, Capstans & Turret lathes-Constructional features. Tool and work holding devices, Tool layout.

04Hrs.

Shaping, Slotting and planning machines:

Classification, constructional features of shaping m/c, slotting m/c, planning m/c. driving mechanisms of shaping, slotting and planning machines. Operations done on shaping machine, slotting machine and planning machine. Calculation of machining time. **04Hrs.**

Drilling machines:

Classification, constructional features of Drilling Machines. Drilling & related operations, types of drill & drill bit nomenclature, drill materials. Calculation of machining time. **03Hrs.**

Unit- 3

Milling machines:

Classification, constructional features, milling cutters nomenclature. Milling operations, up milling and down milling concepts. Calculation of machining time. **02Hrs.**

Indexing:

Simple, compound, differential and angular indexing calculations, Simple numerical on indexing. **04Hrs.**

Unit- 4

Grinding:

Types of abrasives, bonding process, classification, constructional features (cylindrical and surface grinding, center less grinding), selection of grinding wheel. **01Hr.**

Lapping and Honing:

Construction, applications, Principles of operation. **01Hr.**

Non-traditional machining processes:

Principle, need, equipment, operation and LBM, plasma arc machining, Electro chemical machining, ultrasonic machining, abrasive jet machining, water jet machining. **04Hrs.**

Unit- 5

Rapid Prototyping:

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

Stereo Lithography Systems, Selective Laser Sintering and Fusion Deposition Modeling:

Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. **06Hrs.**

MACHINE SHOP LAB.

Preparation of three models on lathe involving: Facing, Plain turning, Taper turning, Step turning, Thread cutting, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

Cutting of "V" Groove/ Dovetail / Rectangular groove: Using Shaping Machine, Cutting of Gear Teeth Using Milling Machine. Demonstration on Grinding Machine.

REFERENCES

Text Books:

1. Workshop Technology by HazaraChoudhry, Vol -II, Media Promoters & Publishers Pvt. Ltd. 2004
2. Production Technology by R.K.Jain, Khanna Publications, 2003.
3. Stereo Lithography and other RP & M Technologies – Paul F. Jacobs – SME NY 1996.

Reference Books:

1. “Production technology “by HMT, Tata McGraw Hill, 2001.
2. “Fundamentals of Metal Machining and Machine Tools” by G. Boothroyd, McGraw Hill, 2000.
3. Fundamentals of Production Planning and Control by Stephen N. Chapman, Prentice Hall, 2005.

MOOCS

1. <http://nptel.ac.in/courses/112105126/>
2. <http://nptel.ac.in/courses/112105127/>
- 3) <https://www.class-central.com/subject/>

COURSE OUTCOMES

CO1	To understand different types of machine tools and their mechanism, types, applications and operations
CO2	Ability to solve machining time, tool life, indexing problems
CO3	Ability to understand failure criteria, heat generation & distribution, selection of cutting fluids
CO4	To understand the principles, advantages and limitations of Non-conventional machining and Rapid Prototyping

Assessment of Self Study:

Student group of 5 members to submit following assignments on Rapid Prototyping at the end of the course.

1. Creation of CAD model of component
2. Conversion of CAD model to STL format
3. Slicing the STL file into thin cross section layers
4. Construction of the model one layer at a time
5. Cleaning and finishing the model
6. Documentation and report submission

Scheme of examination: One question from each unit and choice from Unit 1 and 2.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/ design examination with built-in oral part (Viva Voice).

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
III SEMESTER

Course Title	STRENGTH OF MATERIALS		
Course Code	15IM3DCSOM	L-T-P-S	3-0-0-0

PRE-REQUISITES : NIL

Unit – 1

Simple stress and strain: Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – behavior in Tension for Mild steel and nonferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, Total elongation of tapering bars of circular cross section . Principle of super position, Elongations due to self-weight for constant cross section, simple shear stress, shear strain, elastic constants and their relations, volumetric strain.

Compound bars: General Introduction, plane stress, stresses on inclined sections, General two dimensional stress system, principal stresses and maximum shear stresses, Mohr's circle for plane stress. **12Hrs.**

Unit - 2

Bending moment and Shear force in beams: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load and couple for different types of beams. **06Hrs.**

Unit - 3

Bending and shear stresses in beams: Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses, radius of curvature and bending moment, moment carrying capacity of a section, Shear stress diagram for rectangular, symmetrical I and T section (composite / fletched beams not included). Derivation of Euler Bernoulli deflection equation only. **10Hrs.**

Unit - 4

Torsion of circular shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts. **06Hrs.**

Unit - 5

Thick and thin cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation), (compound cylinders not included).

Columns and Struts: Introduction: Euler's formula for critical load of columns for different end conditions, limitations of Euler's theory, Rankine's formula. No derivation, No Numerical.

06Hrs.

REFERENCES:

Text Books:

1. "Strength of Materials", B.C Punmia, Ashok Jain, Arun Jain, Lakshmi Publications, New Delhi. 3rd Edition, 2002
2. "Elements of Strength of Materials", Timoshenko and Young- Published by Affiliated East-West Press, 1962
3. "Strength of Materials" Ramamrutham, DhanpathRai Publishers, 2008.

Reference Books:

1. "Mechanics of Solids", Mubeen, Pearson Edu. India, 2002
2. "Strength of Materials", W.A. Nash, Schaum's Outline Series, Fourth Edition-2007
3. "Mechanics of materials", S.I. Units, Ferdinand Beer & Russell Johnston, TATA McGrawHill-2003.
4. "Strength of Materials "L. S. Srinath, Prakash Desai & Ananth Ramu TMH Publishers, Chennai, 2008.
5. "Elements of Strength of Materials Timoshenko and Young" Published by Affiliated East-West Press, 1962

E-books:

1. <http://engineeringebookstore.blogspot.in/2013/07/som-strength-of-materials.html>
2. http://free-onlinebooks.blogspot.in/2014/11/download-bc-punmia-strength-of_29.html

MOOCS:

1. <http://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/strength%20of%20materials/homepage.htm>
2. <http://www.onesmartclick.com/engineering/strength-of-material.html>
3. <https://www.class-central.com/subject>

Scheme of examination: One Question from Unit 2, 4, 5 & two questions from unit 1 & 3.

COURSE OUTCOMES

CO 1	Understand the concepts and principles applied to members under various loadings and the effects of these loadings
CO 2	Analyze and design structural members subjected to stresses.
CO 3	Analyze columns and pressure vessels under various loadings
CO 4	To design machine parts and structures to prevent failure.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

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III SEMESTER

Course Title	MECHANICAL MEASUREMENTS AND METROLOGY		
Course Code	15IM3DCMMM	L-T-P-S	3-0-1-0

PRE-REQUISITES: NIL

Unit- 1

Introduction to metrology: definition, types, need of inspection, terminologies, and methods of measurement, selection of instruments, measurement errors, units, measurement standards, calibration.

Comparators: Introduction, features, classification, Mechanical comparators, sigma comparators, electrical and electronic comparators, Solex pneumatic gauge, microscope.

Limits, fits and gauges: Limits, fits, tolerance and allowance, theory of limits and fits and their selection, hole basis and shaft basis system, Indian standard system of limits and fits, simple problems. Interchangeability, selective assembly, limit gauges, Taylor's principle of limit gauging, plug gauges, ring gauges. **10Hrs.**

Unit- 2

Measurement of screw threads and gears: Measurement of various elements of threads, major, minor and effective diameter, measurement of pitch, gear inspection, measurement of tooth thickness, gear tooth caliper, Parkinson's gear tester. **06Hrs.**

Unit-3

Measurement of surface finish: Representation of surface finish as per BIS- methods of measuring surface finish: comparison method and direct instrument measurement- surface inspection by comparison methods: touch inspection, visual inspection, scratch inspection, microscopic inspection, and comparison with standard specimen, surface photographs- Direct instrument measurement: stylus probe instruments. **06Hrs.**

Unit- 4

Transducers: introduction, primary and secondary transducers, classifications of transducers, mechanical transducers: thermal (thermocouple, bimetallic, temp-stik) elastic members: bourdon tube, diaphragm. Electrical transducers: active and passive transducers, piezo-electric transducers (modes of operation of piezoelectric crystals and uses) **08Hrs.**

Unit- 5

Measurement and measurement system: definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-times delay. Errors in measurements, classification of errors.

Pressure measurement: elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, high pressure measurements, bridge man gauge. Vacuum measurement: vacuum gauges viz. McLeod gauge.

Temperature measurement: electrical methods of temperature measurement resistance thermometers, thermistors and thermocouples, pyrometer. **10Hrs.**

LAB EXPERIMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
6. Measurements using Optical Projector / Toolmaker Microscope.
7. Measurements of angle using Sine Center / Sine bar / bevel protractor
8. Measurements of cutting tool forces using
 - a) Lathe tool Dynamometer
 - b) Drill tool Dynamometer.
9. Measurements of gear tooth profile using gear tooth Vernier /gear tooth micrometer.
10. Calibration of micrometer using slip gauges

REFERENCES :

Text Books:

1. "Mechanical measurements" by Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed, 2006.
2. "Engineering Metrology" by R.K.Jain, Khanna Publishers, 1994.
3. "A course in Mechanical Measurements and Instrumentation" by A K Sawhney, J.C Kapur Publishers, 3rd Ed., 1989.

Reference Books:

1. "Engineering Metrology" by I.C.Gupta, DhanpatRai Publications, Delhi
2. "Measurements Systems, Applications & Design, by Ernen O Dobeblein, 5TH ed.
3. "Industrial Instrumentation" Alsutko, Jerry. D.Faulk, Thompson Asia Pvt. Ltd.2002.
4. "Mechanical Measurements", R.S. Shirohi& H.C. Radhakrishna, 3rd Ed., New Age Intl. Pvt Ltd.,

MOOCS :

- 1) www.nptel.ac.in/courses/112106138/
- 2) www.nptel.ac.in/courses/112106139/
- 3) <https://www.class-central.com/subject/>

COURSE OUTCOMES:

CO 1	Is able to understand the concepts of metrology, various standards that are in practice and their applications. Learns about comparators and their use in different contexts, Indian standard system of limits and fits practiced in the manufacturing of products.
CO 2	will possess the knowledge of terminology of Screw threads and Gears. Will be able to measure the different elements of screw threads and gears using different instruments.
CO 3	is able to know understand the meaning of surface finish, BIS- methods of measuring surface finish, is able to use the instruments to assess the surface finish.
CO 4	will possess the knowledge transducers and their types, advantages, and usage of transducers for different applications.
CO 5	is able to understand the concept of measurement and the measurement system, error in measurement, pressure and its measurement using different instruments, temperature and its measurement using different Instruments.

Scheme of Examination: One question from unit 2,3& 4 and 2 questions from unit 1 & 5.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

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III SEMESTER

Course Title	ELEMENTS OF ENERGY SYSTEMS		
Course Code	15IM3DCEES	L -T – P-S	3 -0- 0-0

PRE-REQUISITES: NIL

UNIT - 1

BASICS OF THERMODYNAMICS

Systems, zeroth law, first law - concept of internal energy and enthalpy- applications to closed and open systems - second law - concept of entropy - Clausius inequality. **08 Hrs.**

UNIT- 2

CYCLES AND SYSTEMS

Otto, Diesel and Brayton cycles. IC engines - 4 stroke and 2 stroke engines - brake power - efficiencies - heat balance test - simple problems only. Properties of steam - use of steam tables and Mollier diagram - Rankine cycle – simple problems. **08Hrs.**

UNIT- 3

REFRIGERATION AND AIR CONDITIONING SYSTEMS

Vapour compression refrigeration systems - COP - simple problems – basics and types of air conditioning systems. Reciprocating compressors – volumetric efficiency - power required - simple problems - rotary compressors. Heat transfer - modes of heat transfer - simple problems on conduction-composite wall, cylinder and sphere - convection - flow over flat plate-and radiation. **08Hrs.**

UNIT- 4

BASICS OF FLUID MECHANICS

Introduction - properties of fluid - density, viscosity, pressure and velocity – types of fluid flow - continuity equation - energy - head of fluid - Euler's equation - Bernoulli's equation, flow through pipes - Hagen Poiseuille's law - major and minor losses. **08Hrs.**

UNIT- 5

FLUID MEASUREMENTS

Flow measurements - orifice meter, venturimeter- Rota meter and elbow meter. Pressure measurement - total and static pressure measurements using Pitot tube, manometer, mechanical gauges. Velocity measurements – different types. **08Hrs.**

REFERENCES:

TEXT BOOKS:

1. "Fluid Mechanics", Dr.R.K.Bansal, Lakshmi Publications.
2. "Basic & Applied Thermo Dynamics", Nag P. K. Tata McGraw Hill Co. Ltd., India, 2002.

REFERENCE BOOKS:

1. "Thermal Engineering", Sarkar B. K, Tata McGraw Hill Co. Ltd., India, 2005.
2. "Fluid Mechanics and Hydraulic Machines", Rajput R.K. S.Chand& Co., India 2008.
3. "Engineering Thermo Dynamics", Nag P.K Tata McGraw Hill Co. Ltd., India, 2005.
4. "Thermal Engineering" Rajput R.K, Laxmi Publications (P) Ltd., New Delhi, Edition. 2010.
5. "Fluid Mechanics and Fluid Power Engineering", Kumar D.S, S.K.Kataria& Sons Publishers, India, 6th Edition, 2003.

MOOCS :

1. https://www.edx.org/course/iitbombayx/iitbombayx-me209x-thermodynamics-1384#.U8aBL_mSx8E
2. <https://www.coursera.org/course/introthermodynamics>
3. <https://www.coursera.org/course/thermodynamics>
- 4) <https://www.class-central.com/subject/>

COURSE OUTCOMES

CO 1	Be able to understand the basic concepts of thermodynamics and describe energy exchange processes in terms of various forms of energies like heat and work in the systems.
CO 2	Be able to state the First Law for a closed system, open system and apply the steady flow energy equation to a system of thermodynamic components (heaters, coolers, pumps, turbines etc.) to estimate required balances of heat, work and energy flow.
CO 3	Be able understand the Second Law of Thermodynamics- Heat engines and Refrigerators, Reversible and irreversible processes, Carnot cycle and Entropy.
CO 4	Is able to acquire the knowledge of types of fluids, properties and their characteristics. Will know how to measure the pressure of a fluid at a point will have the knowledge of gauge, absolute and vacuum pressure.
CO 5	Is able to learn about the use of manometers for pressure measurement, pressure of the fluid in static condition on immersed surfaces. Will learn about the concepts of buoyancy and floatation, and the conditions for the body to be in equilibrium.
CO 6	Is able to learn about the kinematics of fluid flow, rate of discharge, and types of fluid flow.

Scheme of Examination: One question from each unit and choice in unit-1 and unit-4

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
COMPUTER AIDED MACHINE DRAWING
III SEMESTER

Course	COMPUTER AIDED MACHINE DRAWING	Course Code	15IM3GCCMD
Credits	05	L-T-P-S	1-0-2-2

PRE-REQUISITES: NIL

Unit- 1

Sections of Solids: Sectioning, Sectional view, Representation of section plane, Hatching, Sectioning of engineering objects like: Square, Pentagonal, Hexagonal prisms, Square, Hexagonal pyramids, Cylinder, Cone and Tetrahedron (Direct and indirect method). **08Hrs.**

Unit- 2

3D Modeling from Orthographic views: Given the 2 or 3 views of a machine component, Generation of the object in 3D environment using software. (**Assignment** - Drawing sheets from industries will be supplied to the group of students and to analyze and create the product using software) **08Hrs.**

Unit- 3

Threaded Fasteners: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. Etc.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly), Proportions for square and hexagonal headed bolts & nuts, simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. **04Hrs.**

Unit- 4

Joints: Assembly of Socket and Spigot cotter joint, Pin or Knuckle joint, protected type flanged coupling, Universal coupling. **08Hrs.**

Unit- 5

Assembly Drawings: Screw jack, Machine vice, Plummer block, Tail stock, Steam stop valve, Ram's bottom safety valve, and simple eccentric. **24Hrs.**

REFERENCES :

Text books:

1. "Machine Drawing" by K.R.Gopalkrishna, 20th Edition, Subhas stores, 2007.
2. "Machine Drawing" by Sri N.D.Bhat&V.M.Panchal, 42nd Edition, Charotar Publishing House, 2007.
3. "Machine Drawing" by N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGraw Hill, 2006.

Reference Book:

1. "Machine Drawing with Auto CAD". GoutamPohit&GouthamGhosh, 1st Indian print Pearson Education, 2005.
2. "Auto CAD 2006, for Engineers and Designers". Sham Tickoo Dream tech 2005.

MOOCS :

- 1) <http://nptel.ac.in/courses/112104172/1>,
- 2) <https://www.class-central.com/subject/>

COURSE OUTCOMES

CO 1	Able to draw different sectional views of engineering objects.
CO 2	Able to draw orthographic views of objects and assemble into 3-D views using software.
CO 3	Able to differentiate between different types of threaded fasteners and joints
CO 4	Able to assemble various engineering assembly drawings.

Scheme of Examination:

Test 1 - covering the syllabus from Unit 1 and 2.

Test 2 - covering syllabus from Unit 3, 4 and 5 (manual drafting).

SEE: One question from unit 1 for 20 marks

One question from unit 4 for 20 marks

One question from unit 5 for 60 marks

Assessment of Self Study:

2D Drawing sheets from Industry will be provided to the group of students to study and create the 3D solid models using software.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

IV SEMESTER SYLLABUS



B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
IV SEMESTER

Course Title	INDUSTRIAL ENGINEERING		
Course Code	15IM4DCIEG	L-T-P-S	3-0-1-2

PRE-REQUISITES : NIL

UNIT 1

INDUSTRIAL ENGINEERING: Meaning, Definition, Objective, Need, Scope, Evolution and developments.

PRODUCTIVITY: Definition of productivity, individual enterprises, task of management Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs, wages and incentives (simple numerical problems). **06 Hrs.**

UNIT 2

WORK STUDY: Definition, objective and scope of work study. Human factors in work study. Work study and management, work study and supervision, work study and worker.

METHOD STUDY: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts. (With simple problems).

MICRO AND MEMO MOTION STUDY: Charts to record moment at work place – principles of motion economy, classification of moments two handed process chart, SIMO chart, and micro motion study. Development, definition and installation of the improved method, brief concept about synthetic motion studies. **09 Hrs.**

UNIT 3

WORK MEASUREMENT: Definition, objective and benefit of work measurement. Work measurement techniques. Work sampling: need, confidence levels, sample size determinations, random observation, conducting study with the simple problems.

TIME STUDY: Time Study, Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating & standard Rating, standard performance, scale of rating, factors of affecting rate of working, allowances and standard time determination. Predetermined motion time study – Method time measurement (MTM) **09Hrs.**

UNIT 4

ERGONOMICS: Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system. Components of man-machine system and their functions – work capabilities of industrial worker, study of development of stress in human body and their consequences. Computer based ergonomics.

DESIGN OF MAN-MACHINE SYSTEM: Fatigue in industrial workers, Quantitative qualitative representation and alphanumeric displays, Controls and their design criteria, control types, relation between controls and displays, layouts of panels and machines. Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.

08Hrs.

UNIT 5

CURRENT TRENDS: Introduction to Agile manufacturing, Lean and Six Sigma, Value Engineering, Just in time, Total quality management, Enterprise resource planning, Supply chain and logistics management.

08Hrs.

INDUSTRIAL ENGINEERING LABORATORY

I. METHOD STUDY

- 1) Recording Techniques using charts.
 - i) Outline process chart.
 - ii) Flow process chart.
 - iii) Multiple Activity Chart.
- 2) Recording Techniques using diagrams.
 - i) Flow diagram.
 - ii) String diagram.
- 3) Application of principle of motion economy:
 - i) Two handed process chart.
- 4) Assembling simple components.
 - i) Peg board assembly.
- 5) Development of Plant Layout using:
 - i) Black board

II. WORK MEASUREMENT

- 1) Rating practice using:
 - i) Walking simulator.
 - ii) Pin board assembly
 - iii) Dealing a deck of cards.
 - iv) Marble collection activity
- 2) Determining the standard time using:
 - i) Simple operations using stopwatch time study.
 - ii) Predetermined Method Time Study (PMTS).

III. ERGONOMICS

- 1) Measurement of heart beat rate, calorie consumption parameters using:
 - i) Walking simulator.
 - ii) Cycle Ergo-meter.
- 2) Effect of human efficiency in work environments:
 - i) Noise.
 - ii) Light.

REFERENCES:

Text Books :

1. "Introduction to work study" ILO, - III Revised Edition, 1981
2. "Motion and Time study" - Ralph M Barnes; John Wiley, 8th Edition, 1985.
3. "Engineered work Measurement" - Weldon, ELBS, Marvin E. Mundel- Motion and Time study, PHI, 1st edition, 1991.

References Books:

1. "Human Factors in Engineering Design" - S Sanders and E J McCormick, 6th Edition, McGraw Hill
2. "Work Study and Ergonomics" - S Dalela and Sourabh, Chand Publishers, 3rd edition.
3. "Introduction to work study" by ILO.
4. "Work Study" - Ralph & Barnes.

Self Study

1. Productivity measurement a case study.
2. Work study measurement a case study.
3. Work measurement application.
4. Design of effective systems of operation.
5. Work Sampling.

MOOCS

- 1) <https://www.class-central.com/subject/>

COURSE OUTCOMES

CO1	Industrial Engineering; to take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods and Management effectively
CO2	Work Study; to eliminate unproductive activities under the control of the Management, Supervisor, worker and the Design of Products and Processes
CO3	Method Study; to use the Charts to record the Activities of the people, materials and Equipment to find alternative methods which minimize waste and to implement the best method.
CO4	Work Measurement Techniques; to improve the processes and find the Standard Time.
CO5	Ergonomics; to design the Man – Machine System to improve Human Efficiency and reduce the effort of the workers

Scheme of Examination :

FIVE Questions to be set with one question from units 1 to 5 carrying 20 marks each. Questions in unit 2 & 3 units will have an internal choice.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/ design examination with built-in oral part (Viva Voice).

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B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
IV SEMESTER

Course Title	STATISTICS FOR ENGINEERS		
Course Code	15IM4DCSFE	L -T – P-S	3 -0- 0-0

PRE-REQUISITES : NIL

Unit 1

The Role of Statistics in Engineering (Data Summary and Presentation): Statistical Thinking, Collecting data, Statistical Modeling Frame work, measure of central tendency and variance, Importance of Data summary and Display, Practical problems solving through tools like Tabular and Graphical display, Pie charts, Constructions of Box Plots, S curves, Frequency polygon, Pareto Graph. **07Hrs.**

Unit 2

Discrete Random Variables and Probability Distributions: Discrete Random variables, Probability distributions and Probability mass functions, Cumulative distribution functions, Mean and Variance of a discrete random variable, discrete uniform distribution, Binominal distribution, Hyper Geometric distribution, Applications.

Continuous Random Variables and Probability Distributions: Continuous random variables, Probability distributions and probability density functions, cumulative distribution functions, Mean and Variance of a continuous random variable, uniform distribution, Normal distribution, Normal approximation to Binominal and Poisson distribution, Applications. Chi-square Distributions, Exponential distribution Weibull Distribution (Underlined Distributions - Exposure limited to theoretical concepts). **10 Hrs.**

Unit 3

Estimation Theory: Statistical Inference, Random sampling, Properties of Estimators, Sampling distribution, Sampling distribution of means, variance and proportion, Introduction to confidence intervals. **05Hrs.**

Unit 4

Statistical Inference for a Single Sample and Two Samples: Hypothesis testing, Inference on the mean of a population (variance known and unknown), Inference on the variance of a normal population, Inference on a population proportion.

Statistical Inference for a Single Sample and Two Samples: Testing for Goodness of Fit, Inference for a difference in Means, Variances known, Inference for a difference in means of two normal distributions, Variances unknown, Inference on the Variances of two normal populations, Inference on two population proportions. **10Hrs.**

Unit 5

Simple Linear Regressions and Correlation: Simple Linear Regression, Properties of Least square Estimators and Estimation of variances, Common abuses of regression, Prediction of new observations, Assessing the adequacy of regression model, Transformations to a straight line, Introduction to multiple regression (will not have problems), Correlation.

Design of Experiments: Strategy of experimentation, completely randomized single - factor experiment, Tests on individual treatment means, the random effects model, the randomized complete block design, one way analysis of variance and two way analysis of variance. (Exposure limited to theoretical concepts) **08 Hrs.**

Statistical Software to be utilized extensively wherever possible to solve problems.

REFERENCES

Text books:

1. "Applied statistics and Probability for Engineers",- Douglas C Montgomery, George C Runger, 2nd Edn, John Wiley and Sons, ISBN-0-471-17027-5
2. "Statistics for Management", - Richard I Levin, David S Rubin, 06th Edn, Prentice Hall India, ISBN-81-203-0893-X.

Reference books:

1. "Probability and Statistics in Engineering", - William W Hines, Douglas C Montgomery, 2nd Edn, John Wiley & Sons
2. "Business Statistics for Management and Economics", - Daniel, Terrell, 06th Edn, Houghton Mifflin Company, ISBN-0-395-062835-0
3. "Probability and Statistics ", - Walpole & Mayer, MacMillan Publishing Company, 1989.

Online Reference: <http://nptel.ac.in/courses.php>

MOOCS

- 1) <https://www.class-central.com/subject/>

COURSE OUTCOMES :

CO 1	Able to Identify the role that statistics in engineering problem-solving process and know methods that engineers use to collect data for making decisions
CO 2	Able to Construct and interpret visual data displays and understand how these graphical techniques are useful in uncovering and summarizing patterns in data
CO 3	Able to Determine probabilities for discrete random variables from probability mass functions and for continuous random variables
CO 4	Able to Perform hypothesis tests and construct confidence intervals on the mean, variance and population proportion of a normal distribution
CO 5	Able to Use linear or multiple linear regressions for building empirical models of engineering and scientific data and use it to estimate a mean or to make a prediction of a future observation.
CO 6	Able to Design and conduct engineering experiments involving several factors using the factorial design approach and know how ANOVA is used to analyze and interpret main effects and interactions

Scheme of Examination : One Question to be set from each unit and Two Questions will be set from the unit 2 & 4. Student will answer any 5 questions selecting at least one from each unit.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
IV SEMESTER

Course Title	MANAGEMENT AND ENTREPRENEURSHIP		
Course Code	15IM4DCMAE	L -T – P-S	3 -0- 0-0

PRE-REQUISITES : NIL

UNIT- 1

MANAGEMENT : Introduction- Historical evolution of management, Thought and its Development, Scope and Functional areas of management, Management as a science, art of profession Management and Administration Roles of Management, Levels of Management, functions of Management **08 Hrs.**

UNIT- 2

PLANNING AND ORGANIZING: Nature, importance and purpose of planning process Objectives Types of plans Importance of planning steps in planning and planning premises Hierarchy of plans.
 Introduction of organization-Principles of organization Types of organization, centralization Vs decentralization of authority and responsibility Span of control, MBO and MBE. **08 Hrs.**

UNIT- 3

STAFFING, DIRECTING & CONTROLLING: Purpose and importance of staffing-selection process and recruitment, appraisal, Meaning and purpose of Directing Leadership styles, motivation theories, communication and Coordination. Techniques of Co-ordination, Meaning and steps in controlling- essentials of a sound control system-methods of establishing control **08 Hrs.**

UNIT- 4

ENTREPRENEURSHIP: Meaning of Entrepreneur, evolution of the concept, functions of an entrepreneur, types of an entrepreneur, Concept of Entrepreneurship, stages in entrepreneurial process; role of entrepreneurs in economic development, Entrepreneurship in India, barriers for entrepreneurship. **04Hrs.**

SMALL SCALE INDUSTRIES : Definition, characteristics; scope and role of SSI in economic development, advantages of SSI, steps to start and SSI changes in government policy

towards SSI in the past 4 decades, Impact of Liberalization, Privatization, Globalization on SSI, Effect of WTO/GATT on SSI, Ancillary industry and tiny industry **04Hrs.**

UNIT- 5

INSTITUTIONAL SUPPORT : Government agencies supporting industrial activities, schemes;TECKSOK, KIADB, KSSIDC, KSIMC,DIC Single window agency, SISI; NSIC, SIDBI, KSFC.- Industrial Finance **04Hrs.**

PREPARATION OF PROJECT: Meaning of project; Project identification; Project selection; project report; need and significance of report; Contents: Network analysis; Errors of Project report: project appraisal, identification of business opportunities; Market Feasibility study technical feasibility study, financial feasibility study and social feasibility study.**04Hrs.**

REFERENCES

Text Books:

1. "Management and Entrepreneurship"- NVR Naidu& T. Krishna Rao, I K Publishing
2. "Dynamics of Entrepreneurial Development & Management"- Vasant Desai, Himalaya Publishing House.
3. "Entrepreneurship Development",-Poornima M. Charantimath, Small Business Enterprises Pearson Education 2006 (For Unit-2 & 4).

Reference Books:

1. "Essentials of Management",- Harold Koontz, Heinz Wehrich, RamachandraAryasri, Tata McGraw Hill, 2010.
2. "Principles of Management", P.C.Tripathi, P.N.Reddy Tata McGraw Hill.
3. "Management Fundamentals Concepts, Application, Skill Development"- Roberts Lusier Thomson
4. "Entrepreneurship Development",- S. S. Khanka S. Chand & Co.
5. "Management",- Stephen Robbins Pearson Education/PHI 17th Edition, 2003.

Online Reference: <http://nptel.ac.in/courses.php>

MOOCS

- 1) <https://www.class-central.com/subject/>

Scheme of Examination: There will be 7 Question to be set one question from each unit and choice from unit 4 and unit 5.

COURSE OUTCOMES :

CO 1	Able to identify the role that statistics in engineering problem-solving process and know methods that engineers use to collect data for making decisions
CO 2	Able to Construct and interpret visual data displays and understand how these graphical techniques are useful in uncovering and summarizing patterns in data.
CO 3	Able to determine probabilities for discrete random variables from probability mass

	functions and for continuous random variables.
CO 4	Able to perform hypothesis tests and construct confidence intervals on the mean, variance and population proportion of a normal distribution.
CO 5	Able to Use linear or multiple linear regressions for building empirical models of engineering and scientific data and use it to estimate a mean or to make a prediction of a future observation.
CO 6	Able to Design and conduct engineering experiments involving several factors using the factorial design approach and know how ANOVA is used to analyze and interpret main effects and interactions.

ASSESSMENT:

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Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

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**B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
IV SEMESTER**

Course Title	PRODUCTION TECHNOLOGY-II		
Course Code	15IM4DCPT-II	L-T-P-S	3-0-1-2

PRE-REQUISITES : NIL

Unit- 1

CASTING PROCESS: Introduction to casting process & steps involved, Varieties of components produced by casting process advantages and limitations of casting process.

Patterns: Definition, functions, materials used for pattern, various pattern allowances and their importance, classification of patterns. Orientation and Parting

Binder: Definition, Types of binder used in moulding sand.

Additives: Need, type of additives used.

Casting Design: Introduction, design consideration on pattern the mould, the parting line, cast holes- cored holes, machined holes, identifying the possible parting line, casting requiring special sand cores, design to obviate sand cores, problems on designing castings.

07Hrs.

Unit- 2

Sand Moulding and special moulding process: Types of base sand, requirement of base sand, Types of sand moulds.

Sand moulds: Moulding sand mixture ingredients (base sand, binder & additives) for different sand mixtures. Method used for sand moulding.

Cores: Definition, Need, Types. Method of making cores, Binders used, Concept of Gating & Riser. Principle involved and types, Fettling and cleaning of castings. Basic steps involved. Casting defects causes, features and remedies.

Moulding Machines: Jolt type, squeeze type, Jolt & Squeeze type and Sand slinger.

Special moulding Process: Study of important moulding processes Green sand, Core sand, Dry sand, Sweep mould, CO₂ sand, Shell mould, Investment mould & Full mould.

Metal moulds: Gravity die-casting, centrifugal casting, Squeeze Casting, Slush Casting, Thixo-casting and continuous casting processes. **10Hrs.**

Unit- 3

Melting Furnaces: Classification of furnaces, Constructional features & working principle of Gas fired pit furnace, Resistance furnace, Coreless Induction furnace, Electric Arc Furnace, Cupola furnace.

Solid Modeling of Casting: Casting features, Modeling Techniques, Graphical user Interface, Model Representation, model exchange format, Model Verification. **06Hrs.**

Unit- 4

WELDING: Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding, Weld Joints, Welding Symbol.

Arc Welding: Principle, Metal Arc welding (**MAW**), Flux Shielded Metal Arc Welding (**FSMAW**), Inert Gas Welding (**TIG & MIG**) **Submerged** Arc Welding (**SAW**) and Atomic Hydrogen Welding processes (**AHW**)

Gas Welding: Principle, Oxy Acetylene welding, Reaction in Gas welding, Flame characteristics, Gas torch construction & working, forward and backward welding.

Special type of welding: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding, Friction welding, Explosive welding, Thermit welding, Laser welding Electron beam welding. **10Hrs.**

Unit- 5

Metallurgical aspect in welding and Casting: Structural analysis, Formation of different zones during Casting and welding. Heat affected zone (**HAZ**). .

Inspection methods: Welding and Casting defects, Detection causes & remedies Methods used for inspection of casting & welding, visual, magnetic particle, Fluorescent particle, and Ultrasonic, Radiography, Eddy Current, and Holography methods of inspection. **07Hrs.**

LAB

1. Testing of Moulding sand and Core sand Preparation of sand specimens and

Conduction of the following tests:

1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Core hardness & Mould hardness tests.
4. Grain fineness number test (Sieve Analysis test)
5. Clay content test.
6. Moisture Content tests.

2. Foundry Practice

- Use of foundry tools and other equipment
- Preparation of moulds using two moulding boxes using patterns or without patterns (Split pattern, Match plate pattern and Core boxes)
- Preparation of one casting (Aluminum or Cast Iron –Demonstration Only).
- Gating System, Bottom gate, Top gate, Parting Gate and Step gate.

3. Welding Process

Preparation of Welding Models using GAS, TIG and MIG Welding.

Self- Study:

Each group consists of minimum two and maximum five students.

At the end of the project students should submit the project report for final assessment.

1. Preparation of Components using Casting Techniques.
2. Flow analysis using appropriate software for Casting.
3. Testing of casted components.
4. Preparation of components using various joints in ARC Welding.
5. Preparation of components using various joints in GAS Welding.
6. Preparation of components using various joints in TIG and MIG Welding.
7. Preparation of components using Brazing techniques.
8. Testing of welded parts.

REFERENCES :

Text Books:

1. "Manufacturing Process-I" ,Dr K. Radhakrishna, Sapna Book House ,5th Ed, 2006.
2. "Manufacturing &Technology : Foundry Forming and Welding ", P.N. Rao 2nd Ed., Tata McGraw Hill , 2003

Reference Books:

1. "Manufacturing Technology" SwaroopKalpakjian, Steuen R Sechmid, Pearson Education Asia, 5th Ed. 2006.
2. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed. Pearson Education, 2006.
3. "Workshop Technology", Vol-I, H.K. HajraChoudhry& A. K. HajraChoudhry, 12th Edition , MPP Publisher, 2001.
4. "Modern Manufacturing Methods"- M. Groover
5. "Metal casting: Computer Aided Design and Analysis", B. Ravi PHI
6. "Design for Manufacture" Harry Peck, Pitman Publishing. 1983.
7. "Product Design and Manufacturing ", by A. K. Chitale and R. C. Guptha. Fifth Edition

Online Reference:

- 1) <http://nptel.ac.in/courses/112107077/> (Advanced Manufacturing Process)
- 2) <http://nptel.ac.in/courses/112107089/> (Welding)
- 3) <http://nptel.ac.in/courses/112107090/> (Welding)

MOOCS

- 1) <https://www.class-central.com/subject/>

COURSE OUTCOMES :

CO 1	To have understood various processes carried out in Foundry.
CO 2	To have studied sand, its importance, it's testing and types of Sand.
CO 3	To have studied and understood various specialized casting process. The technical knowledge will help the learner to move ahead with gait
CO 4	Be able to grasp knowledge regarding various metals joining process. Problems associated with them in the industries.
CO 5	Able to make a Comparative study of all the joining processes such as welding, soldering and brazing along with metallurgical aspects and changes

Scheme of Examination:

One question from each Unit and internal choice from Units 2 & 4

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

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B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
IV SEMESTER

Course	MACHINE DESIGN	Course Code	15IM4DCMCD
Credits	03	L-T-P-S	3-0-0-0

PRE-REQUISITES : NIL

UNIT-1

Design for Static Strength: Design considerations: Codes and Standards, Static strength; Static loads and factor of safety; Theories of failure -Maximum normal stress theory, maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of Stress concentration factor. Combined Stress concentration factor. **06Hrs.**

Design for Fatigue Strength: Introduction, S -N diagram, Low cycle fatigue, High cycle fatigue, and Endurance limit. Modifying factors -size effect, surface effect, Stress concentration effects; Fluctuating stresses, Fatigue strength under fluctuating stresses, Goodman and Soderberg relationship; Stresses due to combined loading. **06Hrs.**

UNIT-2

Joints and Coupling: Design of rigid flange coupling & Bushed pin type flexible coupling. Cotter and Knuckle joints. **06Hrs.**

Design of Shafts: Torsion of shafts, design for strength & rigidity, with steady loading, ASME & BIS codes for design of transmission shafting, shafts under fluctuating loads and combined loads **05Hrs.**

UNIT- 3

Design of Gears: Introduction to Spur, Helical & Bevel gears, Design of spur gear, stresses in gear tooth, Lewis equation, form factor- dynamic and wear load. **05Hrs.**

UNIT- 4

Mechanical Joints: Riveted Joints -Types, rivet materials, Failures of Riveted joints, Efficiency, Welded Joints -Types, Strength of butt and fillet welds. **06Hrs.**

UNIT -5

Lubrication and Bearings: Mechanisms of Lubrication -Viscosity, bearing modulus, coefficient of friction, minimum oil film thickness-Heat Generated, Heat dissipated, bearing materials, lubricants and properties. Examples of journal bearing and thrust bearing design. **06Hrs.**

REFERENCES :

Text Books:

1. "Mechanical Engineering Design" -Joseph Edward Shigley, Tata McGraw Hill, New Delhi 1986.
2. "Machine Design" -V.L. Maleev and Hartman, CBS Publishers & Distribution, Delhi, 1983.
3. "Machine Design" -R.S Khurmi and J.K. Gupta, Eurasia Publishing house (p) Ltd., New Delhi.

Design Data Hand Book:

Design Data Hand Book Vol .I & Vol.2 -Dr. K. Lingaiah, Suma Publications, Bangalore.

Reference Books:

1. "Machine Design" -Robert .L , Norton -Pearson Education Asia, New Delhi, 2001
2. "Theory and Problems of Machine Design", -Hall, Holowinko, Laughlin, - Schaums Outline Series, 2002.
3. "Elements of Machine Design" -N. C. Pandey & C. S. Shah, - Chorotar Publishing House, 2002.
4. "Design of Machine Elements", V.B.Bahandri, Tata McGraw Hill Publishing Co. Ltd., New-Delhi
5. "Machine Component & Design" -William Orthwan, Jaico Publishing Co.
6. "Fundamentals of Design" -Benerad J Hamrock, Bo -Jacobson & Steven R. Schmid.
7. "Fundamentals of Machine Design Component" -Robert C. Juvinall and Kurt M. Marshek - John & sons.
8. "Machine Design" -R. K. Jain ,Khanna Publications, New Delhi.
9. "Design of Machine Elements" -J B K Das and P L Srinivasa Murthy, -Sapna Book House, Bangalore.

Online References:

- 1) <http://nptel.ac.in/courses/112105124/>
- 2) http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/New_index1.html
- 3) http://nptel.ac.in/courses/IIT-MADRAS/Machine_Design_II/

E-books

- 1) <http://www.faadooengineers.com/threads/2060687-Machine-design-by-shigley-ebook-download-pdf>
- 2) <http://www.free4ebook.com/mec.html>

Course Outcome

CO 1	Be able to analyze the stress and strain on mechanical components and understand, identify, and quantify failure modes for mechanical components
CO 2	Demonstrate knowledge on basic machine elements used in machine design, design machine elements to withstand loads and deformations for given application while considering additional specifications
CO 3	Be able to approach a design problem successfully taking decision when there is not a unique answer.
CO 4	To develop an ability to use techniques, skills, and modern engineering tools necessary for engineering practice

MOOCS

- 1) <https://www.class-central.com/subject/>

Scheme of Examination:Two questions from units 1 & 2 and one question from units3,4&5.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.



B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT
IV SEMESTER

Course	MATERIAL SCIENCE AND METALLURGY	Course Code	15IM4DCMSM
Credits	04	L-T-P-S	3-0-1-0

PRE-REQUISITES : NIL

Unit – 1

Introduction to Material Science and Metallurgy: Classification of Engineering Materials, Engineering requirements of materials, Factors affecting mechanical properties, Selection of materials for Engineering application, Effect of grain size on properties of metals, Crystal imperfections: point, line, surface defects. Diffusion in solids: Diffusion Mechanism, Fick's laws of diffusion. Plastic deformation by slip & twinning **06Hrs**

Unit - 2

Testing of Materials: Tensile properties, Engineering stress-strain, true stress & strain, Hardness testing (Brinell hardness testing, Vickers, Rockwell hardness test)

Types of Fracture: Brittle and Ductile fracture, Brittle to ductile transition, Griffith's criterion.

Creep: The creep curves, creep mechanism and factors affecting creep.

Fatigue: Fatigue cycles, Fatigue test, S.N curves, Fatigue mechanism, Factors affecting fatigue life. **08Hrs**

Unit - 3

Solid solutions and phase diagrams: Types of solids solutions, Rules of governing the formation of solid solutions and intermediate phases. Cooling curves, construction of phase diagrams, Phase diagrams of Eutectic systems Phase rules: Gibbs phase rule and Lever rule. Interpretation of phase diagrams. Iron carbon equilibrium Diagram; Equilibrium phases, Invariant reactions, critical temperatures, Solidification of steels. **10Hrs**

Unit - 4

Heat treatment of Ferrous and Non-ferrous materials: TTT diagram, Construction of TTT diagram, TTT diagram for hypo and hyper eutectoid steels cooling curves, Non equilibrium phases, Effect of alloying elements on steels.

Heat treatment processes- Annealing, and its types, normalizing, hardening and hardenability, tempering, surface heat treatment methods. Heat treatment of Non-ferrous materials.

Ferrous, Non-ferrous and Advanced materials.

Ferrous - Types, Composition, Properties and applications of plain carbon steels and cast irons. Designation of steels.

Non-ferrous: Aluminum and its alloys, Magnesium alloys, Copper and its alloys **10Hrs**

Unit 5

Composite Materials-Definition, Classifications, Production methods, properties and applications of MMC and FRP composites.

Nano material: Nano powders, and nanomaterial, methods of preparation- plasma arcing, chemical vapor deposition electro deposition, sol-gel synthesis, ball milling, and comparative studies of the advantages and disadvantages of Nano powder production technologies. **06Hrs.**

LAB. EXPERIMENTS

Tensile, shear and compression tests of metallic and nonmetallic specimens using a Universal Testing Machine,

Torsion tests, Bending Test on metallic and nonmetallic specimens. Fatigue Test Izod and Charpy tests on M.S. Specimen Brinell, Rockwell and Vickers's Hardness test.

1. Examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, Grey C.I, SG iron, Brass, Bronze & composites. (Preparation of specimen demo)
2. Heat treatment: Annealing, normalizing, hardening and tempering of steel Hardness studies of heat-treated Samples (Demo).
3. To study the wear characteristics of one ferrous, and one non-ferrous and composite materials for different parameters
4. Demo on Non-destructive test experiments like,
 - (a). Magnetic crack detection
 - (b). Dye penetration testing, to study the defects of Casted and Welded specimens

Text Books:

1. "Materials Science & Engineering-An Introduction", William D. Callister Jr. Wiley India Pvt. Ltd. 6th Edition, New Delhi 2006.
2. "Foundation of Material Science and Engineering", Smith, 3rd Edition McGraw Hill, 1997.

Reference Books:

1. "Introduction to Material Science for Engineering", 6th edition James F. Shackelford, Pearson, Prentice Hall, New Jersey, 2006.
2. "Mechanical Metallurgy" 3rd Edn. George. E. Dieter, McGraw Hill, 2001.
3. "Basic Science and Emerging technique", -Mick Wilson , KamaliKannangara, First Indian edition ,2005.

COURSE OUTCOMES :

CO 1	Understand all class of materials and their structure, properties, processing, applications and performance.
CO 2	Understand the process of testing materials and to study the behavior of material.
CO 3	Know the importance and construction of Iron-carbon diagram time temperature transformation curve, heat treatment processes
CO 4	Understand ferrous, nonferrous and advanced composition, properties and application
CO 5	Understand how the Nano materials are useful in production technologies

MOOCS

- 1) <https://www.class-central.com/subject/>

Online References:

1. <http://nptel.ac.in/courses/113106032/> (Structures of materials)
2. <http://nptel.ac.in/courses/113101003/> (Phase transformation and Heat Treatment)
3. <http://nptel.ac.in/courses/113108052/> (Defects in solids)

Scheme of Examination: Each Question from each unit and internal choice from Unit 3 & 4.

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination(SEE)-a written examination for theory courses and practical/design examination with built-in oral part (Viva Voice).

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

Lateral Entry : Mathematics for Diploma students

THIRD SEMESTER B.E COURSE (All Branches)

Course Title	Mathematics-I	Course Code	15MA3IMMAT
Credits	00	L – T – P- S	0 – 0 – 0 - 0
Contact hours	48 hours (36L+12T)	III semester Lateral Entry students	

Prerequisites: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

Course Objectives: To provide students with a solid foundation in mathematical fundamentals such as differentiation, differential equations, vectors and orthogonal curvilinear coordinates for different branches of engineering.

UNIT 1

DIFFERENTIAL AND INTEGRAL CALCULUS

[9 Hours]

List of standard derivatives including hyperbolic functions, rules of differentiation. Differentiation of product of two functions using Leibnitz rule (direct problems). Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals – problems.

(7L+2T)

UNIT 2

POLAR COORDINATES AND PARTIAL DERIVATIVES [10 Hours]

Polar curves: Polar coordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Taylor's and Maclaurin's series expansion for functions of two variables. Jacobians and their properties (without proof) – Problems. (7L+3T)

UNIT 3

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS [8 Hours]

Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories. (6L+2T)

UNIT 4

SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS

[9 Hours]

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type $f(x) = e^{ax}$, $\sin(ax)$, $\cos(ax)$, x^n , $e^{ax}\sin(bx)$, $e^{ax}\cos(bx)$. Method of variation of parameters. Cauchy's and Legendre differential equations. (7L+2T)

UNIT 5

VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES (OCC)

[8 Hours]

Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof). Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in OCC. (6L+2T)

Bibliography

Text Books:

- Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
- Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill.

Reference Books:

- Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers
- Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

E books and online course materials

- (1) Engineering Mathematics, [K. A. Stroud, Dexter J. Booth](#), Industrial Press, 2001
http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
- (2) Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
- (3)<http://ocw.mit.edu/courses/mathematics/> (online course material)

Online Courses

1. [https:// www.khanacademy.org/Math](https://www.khanacademy.org/Math)
2. [https:// www.class-central.com/subject/math](https://www.class-central.com/subject/math) (MOOCS)
3. E-learning: www.vtu.ac.in .

On completion of the course the student will have the ability to

Course Code	CO	PO	Bloom's level
15MA3IMMAT	CO-1: Understand the basic concepts of differentiation and integration.	1	2
	CO-2: Apply the concepts of polar curves and multivariate calculus.	1	2
	CO-3: Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.	1	3
	CO-4: Apply techniques of vector calculus to engineering problems.	1	3
	CO-5: Comprehend the generalization of vector calculus in curvilinear coordinate system.	1	3

Program Outcome:

1. Graduates will apply knowledge of Mathematics, Science and Engineering concepts to solve problems pertinent to relevant engineering field.

FOURTH SEMESTER B.E COURSE

Course Title	Mathematics-II	Course Code	15MA4IMMAT
Credits	00	L – T – P- S	0 – 0 – 0 - 0
Contact hours	48 hours (36L+12T)	IV semester Lateral Entry Students	

Prerequisites: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

Course Objectives: To provide students with a solid foundation in mathematical fundamentals such as Laplace Transforms, Solution of ordinary differential equations using Laplace Transforms, vector integration, computation of area and volume using double integrals and triple integrals respectively.

UNIT 1

LAPLACE TRANSFORMS **[8 Hours]**

Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting. Unit step function. **(6L+2T)**

UNIT 2

INVERSE LAPLACE TRANSFORMS **[9 Hours]**

Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE-Initial and Boundary value Problems. **(7L+2T)**

UNIT 3

DOUBLE INTEGRAL **[11 Hours]**

Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area. **(8L+3T)**

UNIT 4

TRIPLE INTEGRALS AND IMPROPER INTEGRALS **[8 Hours]**

Evaluation of triple integral. Application: Volume. Gamma and Beta functions-definition Relation between Gamma and Beta functions. Properties and Problems. **(6L+2T)**

UNIT 5

VECTOR INTEGRATION **[8 Hours]**

Line integral. Green's theorem. Stokes' theorem. Gauss divergence theorem. **(6L+2T)**

Bibliography

Text Book:

- Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
- Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd

Reference Book:

- Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers.
- Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill.

E books and online course materials

(1) Engineering Mathematics, [K. A. Stroud](#), [Dexter J. Booth](#), Industrial Press, 2001

http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.

(2) Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

(3) <http://ocw.mit.edu/courses/mathematics/> (online course material)

Online Courses

1. [https:// www.khanacademy.org/Math](https://www.khanacademy.org/Math)
2. [https:// www.class-central.com/subject/math](https://www.class-central.com/subject/math) (MOOCS)
3. E-learning: www.vtu.ac.in

On completion of the course the student will have the ability to

Course Code	CO	PO	Bloom's level
15MA4IMMAT	CO-1: Obtain solution of ordinary differential equations using Laplace Transform techniques.	1	3
	CO-2: Apply double integrals to compute areas and triple integrals in computing volumes.	1	3
	CO-3: Use Gamma and Beta functions to evaluate integrals.	1	2
	CO-4: Use of integral calculus in scalar and vector fields.	1	3

Program Outcome:

1. Graduates will apply knowledge of Mathematics, Science and Engineering concepts to solve problems pertinent to relevant engineering field.