RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

INDUSTRIAL ENGINEERING AND MANAGEMENT

III & IV SEMESTER B.E

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute:

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 13 UG programs and 15 PG programs. All these programs are approved by AICTE. All the UG programs & 09 PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with 'A' grade by NAAC in 2014. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs till the year 2029. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 60% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility to all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology & Schneider Centre of Excellence. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 65 & world ranking 578 for the year 2020.**

The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology secured All India Rank 8th for the year 2020 for Atal Ranking of Institutions on Innovation Achievements (ARIIA), an initiative of Ministry of Human Resource Development (MHRD), Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. MSRIT is a member of DELNET, CMTI and VTU E-Library Consortium. MSRIT has a modern auditorium and several hi-tech conference halls with video conferencing facilities. It has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework, MHRD, Government of India, M S Ramaiah Institute of Technology has achieved 59th rank among 1071 top Engineering institutions of India for the year 2020 and 1st rank amongst Engineering colleges (VTU) in Karnataka.

About the Department:

The department was established in the year 1979 as Industrial & Production Engineering and renamed as Industrial Engineering & Management in the year 1992, with an intake of 60 students and M.Tech program was commenced in the year 2012. The department has been recognized as R&D center by VTU with 14 scholars pursuing their Ph.D. The department has well modernized laboratories namely Industrial & Quality Engineering lab, Computer Lab and Mechanical Measurement & Metrology lab. The department is having highly qualified, motivated and result oriented faculty members. All the faculty are involved in research and technical paper publications in reputed technical journals, conferences across the world. The department was accredited by the NBA in 2001, 2004, 2010 & reaccredited in year 2015 as per the new NBA format laid down by Washington Accord. It has consistently bagged university ranks in Bangalore University & VTU. It has set a unique record of achieving 1st rank eleven times. The department has successfully conducted around 37 faculty development programs, seminars & workshops for academicians as well as industry personnel, students and technical staff. The society of Industrial Engineering and Management, “INDEMAN SOCIETY”- a student body was established in the year 1996. The activities of this society includes: Regular Industrial visits and Guest lectures are conducted twice every semester for all students. The department also has Quality Engineering Club, Materials & Manufacturing Club and Productivity Club, the students can enroll to carryout activities based on their interest. Many funded research projects are executed which are sponsored by UGC, AICTE, DST, VTU and VGST.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

- Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
- Establishing research clusters in emerging areas in collaboration with globally reputed organizations
- Establishing innovative skills development, techno entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at MS Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To nurture engineers, entrepreneurs who develop solutions to continually improve socio-technical systems and add value to the society

MISSION OF THE DEPARTMENT

The Industrial Engineering and Management Department shall transform the entrants of the Industrial Engineering and Management program into professionally competent engineers through innovative educational curricula, balanced research program and effective collaboration with industry and academia

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1: Use the knowledge and skills of industrial engineering to model and analyze the real life problems and interpret the results.

PEO2: Effectively design, implement, improve and manage the integrated socio-technical systems.

PEO3: Build and lead cross-functional teams, upholding the professional responsibilities and ethical values.

PEO4: Engage in continuing education and life-long learning to be competitive and enterprising.

PROGRAM OUTCOMES (POs):

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional

engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being

Able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO 1: Develop Knowledge, Skills and abilities in the fields such as System design and development, Manufacturing and Research.

PSO 2: Apply the core competence in the field of industrial and systems engineering to solve real world problem and continuously improve its performance.

PSO 3: Exhibit innovative abilities and develop towards entrepreneurial careers with a focus on leadership and responsibility.

Semester wise Credit Breakdown for B E Degree Curriculum

Batch 2019-23

Semester	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Sciences (BSC)	9	8	4	4					**25**
Engineering Science (ESC)	11	10							**21**
Humanities, Social Sciences and Management (HSMS)		2			3		3		**8**
Professional Courses- Core (PCC)			21	21	15	11	10		**78**
Professional Courses - Electives (PCE)					3	3	6	3	**15**
Other Open Electives Courses (OEC)					3	3			**6**
Project Work (PROJ), Internship (IN)						4	1	17	**22**
Total Credits	**20**	**20**	**25**	**25**	**24**	**21**	**20**	**20**	**175**

SCHEME OF TEACHING
III SEMESTER B.E. INDUSTRIAL ENGINEERING AND MANAGEMENT

Sl.No.	Subject Code	Subject	Category	Credits			
				L*	T*	P*	Total
1	IM31	Engg. Mathematics – III	BSC	3	1	0	4
2	IM32	Materials Science and Metallurgy	PCC	4	0	0	4
3	IM33	Manufacturing Processes	PCC	4	0	0	4
4	IM34	Mechanics of Materials	PCC	3	1	0	4
5	IM35	Fluid and Thermal systems	PCC	4	0	0	4
6	IM36	Work Study and Ergonomics	PCC	3	0	0	3
7	IML37	Materials Testing Lab	PCC	0	0	1	1
8	IML38	Work Study and Ergonomics Lab	PCC	0	0	1	1
			Total	**21**	**2**	**2**	**25**

L- Lecture (one hours) **T-** Tutorial (Two hours) **P-**Practical (Two hours)

Note:

1. **The Non Credit Mandatory Course, Additional Mathematics – I** is prescribed for III Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other III semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE to appear for SEE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

Sl. No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1	AM31	Additional Mathematics - I	BSC	0	0	0	0	3

2. **AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):**
   Every regular student, who is admitted to the 4 year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years Degree Program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8th Semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; eight semester Grade Card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the Eight Semester grade card.

SCHEME OF TEACHING
IV SEMESTER B.E. INDUSTRIAL ENGINEERING AND MANAGEMENT

Sl. No.	Subject Code	Subject	Category	Credits			
				L*	T*	P*	Total
1	IM41	Engg. Mathematics – IV	BSC	3	1	0	4
2	IM42	Mechanical Measurements and Metrology	PCC	4	0	0	4
3	IM43	Machine Tool Technology	PCC	4	0	0	4
4	IM44	Materials Management	PCC	4	0	0	4
5	IM45	Mechanisms and Machine Design	PCC	3	1	0	4
6	IM46	Facilities Planning and Design	PCC	3	0	0	3
7	IML47	Manufacturing Processes Lab	PCC	0	0	1	1
8	IML48	Computer Aided Machine Drawing Lab	PCC	0	0	1	1
			Total	**21**	**2**	**2**	**25**

L- Lecture (one hours) **T-** Tutorial (Two hours) **P-**Practical (Two hours)

Note:

1. **The Non Credit Mandatory Course, Additional Mathematics – II** is prescribed for IV Semester Lateral Entry Diploma students admitted to BE Program. The student shall register for this course along with other IV semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE to appear for SEE. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1	AM41	Additional Mathematics - II	BSC	0	0	0	0	3

2. **AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):**
Every regular student, who is admitted to the 4 year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years Degree Program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students 8th Semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points, Eight semester Grade Card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the Eight Semester grade card.

III Semester

ENGINEERING MATHEMATICS-III

Course Code: IM31 **Credit:3: 1: 0**
Prerequisite: Calculus **Contact Hours: 42L+14T**
Course Coordinators: Dr. Dinesh P A

Course Content

Course Objectives

The students will

1. Learn to solve algebraic, transcendental and ordinary differential equations numerically.
2. Learn to fit a least squares curve and find correlation and regression for a statistical data.
3. Learn the concepts of consistency and solve linear system of equations and system of ODE's using matrix method.
4. Learn to test for convergence of positive terms and represent a periodic function in terms of sine and cosine.
5. Understand the concepts of calculus of functions of complex variables.

Unit I

Numerical solution of Algebraic and Transcendental equations: Method of false position, Newton - Raphson method.

Numerical solution of Ordinary differential equations: Taylor's series method, Euler's & modified Euler's method, fourth order Runge-Kutta method.

Statistics: Curve fitting by the method of least squares, fitting linear, quadratic and geometric curves, Correlation and Regression.

Unit II

Linear Algebra: Elementary transformations on a matrix, Echelon form of a matrix, rank of a matrix, consistency of system of linear equations, Gauss elimination and Gauss – Seidel method to solve system of linear equations, Eigen values and eigen vectors of a matrix, Rayleigh power method to determine the dominant eigen value of a matrix, Diagonalization of square matrices, Solution of system of ODE's using matrix method.

Unit III

Fourier Series: Convergence and divergence of infinite series of positive terms, Periodic functions, Dirichlet conditions, Fourier series of periodic functions of period 2π and arbitrary period, half range Fourier series, Practical harmonic analysis.

Unit IV

Complex Variables - I: Functions of complex variables, Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions.

Transformations: Conformal transformation, Discussion of the transformations $w = e^z$, $w = z^2$ and $w = z + \frac{a^2}{z}$, $(z \neq 0)$, Bilinear transformations.

Unit V

Complex Variables-II: Complex integration, Cauchy's theorem, Cauchy's integral formula, Taylor's & Laurent's series (statements only), Singularities, poles and residues, Cauchy residue theorem.

Text Books

1. Erwin Kreyszig –Advanced Engineering Mathematics – Wiley publication – 10th edition-2015.
2. B. S. Grewal –Higher Engineering Mathematics – Khanna Publishers – 44th edition – 2017.

References

1. David C. Lay, Steven R. Lay and Judi J. Mc. Donald – Linear Algebra and its Applications – Pearson – 5th edition – 2015.
2. Glyn James – Advanced Modern Engineering Mathematics – Pearson Education – 4th edition – 2010.
3. Dennis G. Zill and Patric D. Shanahan- A First Course in Complex Analysis with Applications- Jones and Bartlett Publishers – 2nd edition–2009.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Apply numerical techniques to solve engineering problems and fit a least squares curve to the given data. (PO-1,2 & PSO-1,2)
2. Test the system of linear equations for consistency and solve ODE's using Matrix method. (PO-1,2 & PSO-1,2)
3. Construct the Fourier series expansion of a function/tabulated data.(PO-1,2 & PSO-1,2)
4. Examine and construct analytic functions. (PO-1,2 & PSO-1,2)
5. Classify singularities of complex functions and evaluate complex integrals. (PO-1,2 & PSO-1,2)

MATERIALS SCIENCE AND METALLURGY

Course Code: IM32 **Credit:4: 0: 0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator(s): Dr.M.Shilpa/S.Hamritha

Course Content

Unit – I

Crystal Structure: Unit Cells, Crystal systems, BCC, FCC, and HCP structures, Coordination number and atomic packing factors (No Analytical Treatment)
Crystal Imperfection: Point, line, surface imperfections and volume defects
Atomic Diffusion: Fick's laws of diffusion, Factors affecting Diffusion, Steady and non-steady state diffusions

Unit –II

Deformation of materials - Deformation in single crystals, slip and twinning
Fracture: Types of fracture, ductile and brittle fracture mechanisms, Ductile to brittle transition, Temperature
Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, factors causing fatigue, design considerations to avoid fatigue.
Creep: Description of the phenomenon with examples, stages of creep. Properties, factors affecting creep

Unit –III

Solidification: Technological significance, nucleation, applications of controlled nucleation
Phase Diagrams: Solid solutions, Substitutional, and interstitial solid solutions, Hume Rothary rules, Gibbs phase rule, Lever rule, Eutectic, Eutectoid, Peritectic and Peritectoid Phase diagrams
Iron carbon equilibrium diagram: Construction and description of phases, Solidification of steels and cast irons, Time Temperature Transformation curves, Continuous Cooling Curves.

Unit –IV

Heat treatment: Heat treatment of ferrous alloys, Classification of heat treatment processes, Full heat treatment: Annealing and its types, normalizing, Hardening, tempering, Martempering, Austempering Surface heat treatment: carburizing, cyaniding, Nitriding, Flame hardening and induction hardening. Heat treatment of non-ferrous alloys: Age hardening, precipitation hardening, duplex ageing, particle coarsening.
Recovery, Recrystallization and Grain Growth: Recovery - mechanism, recrystallization – mechanism, grain growth

Unit – V

Alloy Development: Properties and Applications of Steels, Cast iron, Super alloys (Nickel-based), Titanium alloys, Aluminum Alloys

Composites: Classification, properties and applications

Nanomaterials: Characteristics, advantages and applications of Nano materials in electronics, Automobiles, textile, sports, domestic appliances, medicine and defense Composites and ceramics

Selection of materials: Criteria for selection of materials, Material selection for aircraft industry, automobile sector and bio-medical applications

Text Books

1. William D Callister, "An Introduction -Material's Science and Engineering", JohnWiley and Sons India Pvt Ltd., 9th Edition, 2014 New Delhi.
2. Smith -Foundation of Material Science and Engineering, 3rd Edition, Mc GrawHill, 1997.
3. Donald R Askland, Pradeep.p.phule -Essentials of Materials for Science and Engineering, Thomson Engineering, 4th edition 2003.
4. William & Smith –Materials Science and Engineering, in SI units, TMH, Special Indian edition 2008.

Reference Books

1. V Raghavan -Physical Metallurgy, Principles and Practices, PHI, 2nd Edition 2006, New Delhi.
2. H. Van Black and Addison -Elements of Material Science and Engineering, Wesley Edition, 1998.
3. James F Shackelford -Introduction to Material Science for Engineering, 6th edition Pearson Prentice hall, New Jersey, 2006.

Course Outcomes (COs):

At the end of the course, students will be able to

1. To identify the different types of crystal structures and imperfections present in them (PO-3& PSO1)
2. To analyze how materials fail and how the failures can be reduced (PO-3& PSO1)
3. To construct the phase diagrams and identify the different phases (PO-3& PSO1)
4. To identify the right material strengthening mechanism for a given application (PO-3, 7& PSO2)
5. To analyze the requirements of the given application and then select the right material for it (PO-7& PSO2)

MANUFACTURING PROCESSES

Course Code: IM33 **Credit:4: 0: 0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator(s): Sudheer D. Kulkarni / Dr. R. Shobha

Course Content

Unit I

Introduction: Definition of manufacturing, Classification of Manufacturing/ Production Processes, Selecting Materials & Manufacturing Processes
Metal Casting Process: Introduction, Steps involved in casting advantages and limitations, Pattern types, pattern allowances, pattern materials. Sand Casting, Types of molding sand, Ingredients of molding sand, properties; Molding Machines- Sand Slingers, Jolt-Squeeze Machine
Principles of Gating: Elements of gating system, types of gates, gating ratio, function of risers, types of risers- open, and blind risers.

Unit II

Special Metal Casting Processes: Expendable-Mold, Permanent-Pattern Casting Processes: Shell-mold casting, Sodium Silicate process, Plaster-mold casting, Ceramic-mold casting, Vacuum casting
Expendable-Mold, Expendable-Pattern Casting Processes: Expendable-pattern casting (lost foam), Investment casting (lost-wax process)
Permanent-Mold Casting Processes: Pressure Casting, Die casting, Centrifugal Casting, Continuous Casting
Melting Furnaces: Electric furnaces-Arc, resistance and induction furnaces. Crucible Furnaces, Cupola-construction, preparation and operation of conventional cupola.

Unit III

Testing and Inspection of Castings: Defects in Castings-Causes and remedies, cleaning and inspection of castings, fettling operations, Non-destructive testing: X-ray radiography, dye penetrate test, ultrasonic test, magnetic particle inspection
Advanced Welding Processes: Introduction, Thermite welding, Friction welding, Explosive welding, Ultrasonic welding, Electron beam welding, Laser welding. Spot, Seam, Projection welding- Welding principle, advantages, disadvantages and applications.
Metallurgical aspect of Welding: Solidification and Structure of welds, Heat affected zone, residual stress, Welding defects.

Unit IV

Bulk Deformation Processes: Definition, Types,Hot Working, Warm Working and Cold working of metals. Forging; Rolling; Extrusion; Rod, Wire, and Tube drawing; Swaging; Defects in formed components
Processing of Metal Powders, Ceramics, Glasses: Powder Metallurgy, Compaction

of Metal Powders, Sintering, Secondary and Finishing Operations, Shaping Ceramics, Forming and Shaping Glass

Unit V

Composite Materials: Metal-Matrix Composites; Liquid-phase processing, solid-phase processing, Two-phase processing.

Rapid Prototyping: Stereolithography, Polyjet, Fused-decomposition modeling, Selective laser sintering, Three-Dimensional Printing: Direct (rapid) manufacturing

Text Books

1. Serope Kalpakjian and Steven R. Schniid - Manufacturing Processes for Engineering MaterialsTechnology, Pearson Education Asia, 5th Edition. 2015.
2. R. K. Rajput, A Textbook of Manufacturing Technology, Second Edition, Laxmi Publications, 2015
3. P.N. Rao -Manufacturing Technology: Foundry Forming and Welding, 2nd edition., TMH, 2003
4. E. Paul Degarmo -Materials and Processes in Manufacturing, 9th edition, PHI, 2011.

References

1. John A. Schey–Introduction to Manufacturing Processes, 3rd Edition, McGraw Hill International Editions,2000
2. Roy A Lindberg -Material and Processes of Manufacture, PHI Publishers, 4th edition, Pearson Education, 2006.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Select a suitable material and manufacturing process to be employed for a given application and understand the basics of casting process. (PO-1,6,7& PSO:1)
2. Compare the various moulding methods and also select a suitable furnace for a given metal. (PO-1,6,7& PSO1)
3. Identify the defects in castings by suitable inspection method; Select a suitable welding technique for the given application (PO-1,6,7& PSO1)
4. Enhance their knowledge in the area of forming techniques and select a processing technique for metals, ceramics, & glass (PO-1,6,7& PSO1)
5. Apply the knowledge of processing Composite Materials and understand the importance of rapid prototyping (PO-1,6,7& PSO1)

MECHANICS OF MATERIALS

Course Code: IM34 **Credit:3: 1: 0**

Pre requisite: Nil **Contact Hours: 42L+12T**

Course Coordinator(s): A. Balakrishna / Sudheer D. Kulkarni

Course Content

Unit I

Simple stress and strain: Introduction, Properties of Materials, Stress, Strain, Hook's law, Poisson's Ratio, Stress- Strain Diagram for structural steel and non- ferrous materials, Principles of superposition, Total elongation of tapering bars of circular cross section. Elongation due to self- weight.

Stresses in Composite sections: Volumetric strain, expression for volumetric strain, Elastic constants, relationship among elastic constants, Thermal stresses including compound bars.

Unit II

Compound bars: Introduction, Stress components on inclined planes, General two dimensional stress system, Principal planes and stresses, Mohr's circle of stresses.

Torsion of circular shafts: Introduction, Pure torsion-torsion equation of circular shafts, Strength and stiffness, Torsional rigidity, torsional flexibility, Power transmitted by shaft solid and hollow circular sections. (Simple problems)

Unit III

Bending moment and shear force in beams: Introduction, Types of beams loadings and supports, Shearing force in beam, Bending moment, Sign convention, Relationship between loading shear force and bending moment, SFD and BMD with salient values for cantilever beams, simply supported beams and overhanging beams considering point loads, UDL, UVL and Couple.

Unit IV

Bending stress in Beams: Introduction, Bending stress in beam, Assumptions in simple bending theory, pure bending, derivation of Bernoulli's equation, Modulus of rupture, section modulus, Flexural rigidity Beam of uniform strength.

Deflection of Beams: Introduction, differential equation for deflection, slope and moments, Double integration method for cantilever for point load and UDL

Unit V

Elastic stability of columns: Introduction, Euler's theory on columns, Effective length slenderness ratio, Short and long columns, radius of gyration, buckling load, Assumptions, derivations of Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine's formula

Thin and thick cylinders: Thin and thick cylinders-Thin cylinders subjected to change

in length, diameter and volume, Lames equations for thick cylinders (compound cylinders not included)

Text Books

1. Basavarajaiah and Mahadevappa, Strength of Materials, University Press, 2010
2. Ramamrutham, Strength of Materials, Dhanapath Rai Publishers, 2008.

References

1. L.S.Srinath, Prakash Desai and AnanthRamu - Strength of Materials, TMH Publishers, Chennai, 2008.
2. S.S Bhavikatti -Strength of Materials, Vikas Publications House pvt. Ltd, 3rd edition 2009.
3. Timoshenko and Young -Elements of Strength of Materials, Affiliated East-Wes Press, 2nd edition 2007.

Course outcomes (COs):

At the end of the course, students will be able to

1. Judge the effect of stress & strain on various mechanical/machine members of various engineering materials (PO-1,2& PSO1)
2. Analyze the effect of compound stresses on members and effect of torsional moment on rigidity and strength of circular members. (PO-1,2,4& PSO1)
3. Determine the strength and rigidity of various cross sections using SFD and BMD. (PO-1,2,4& PSO1)
4. Design suitable cross sectional dimensions based on bending stress limitations and deflection caused due to stresses and loads. (PO-1,2,3,4& PSO1)
5. Determine the cross sectional dimensions of cylindrical pressure vessels for various stress conditions and to design suitable dimensions for columns and struts based on suitability of euler's and rankine's formula for crushing stresses. (PO-1,2,4& PSO1)

FLUID AND THERMAL SYSTEMS

Course Code: IM35 **Credit:4: 0: 0**
Prerequisites: Nil **Contact hours:56**
Course coordinators: Dr. S Appaiah/ Dr. M R Shivakumar

Course Content

Unit I

Properties of fluids: Introduction to fluid mechanics and its applications, properties of fluids, viscosity, thermodynamics properties, surface tension, capillarity, vapor pressure and cavitation.
Fluid pressure: Fluid pressure at a point, pascal's law, pressure variation in a static fluid, absolute, gauge, atmosphere and vacuum pressure. Manometers, simple and differential manometers
Fluid Kinematics: Types of fluid flow – introduction, continuity equation in three dimensions (Cartesian co-ordinate system only)

Unit II

Fluid Dynamics : Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, limitation of Bernoulli's equation, fluid flow measurements, veturi – meter, vertical orifice meter, pitot tube.
Flow through pipes: Frictional loss in pipe flow, Darcy's – equation and Chezy's equation for loss of head due to friction in pipes, hydraulic gradient line and total energy line.

Unit III

Fundamental Concepts & Definitions: Thermodynamics-definition and applications. Microscopic and macroscopic view point. System-types of systems, boundary, Thermodynamic properties- intensive and extensive properties, Thermodynamic state, path, process, cyclic and non-cyclic processes, quasi-static process, point and path functions. Thermodynamic equilibrium, Temperature-zeroth law of thermodynamics, concepts, temperature measurement scales.
Work & Heat: Definition of displacement work and its limitations, similarities and dissimilarities of heat and work. Expressions for displacement work in various processes through P-V diagrams

Unit IV

First Law of Thermodynamics: Joule's experiments, Statement of the First law of thermodynamics-cyclic and non-cyclic processes, Energy-energy as a property, modes of energy, specific heat at constant volume, enthalpy, specific heat at constant pressure, Energy of an isolated system. Extension of the First law to control volume; Mass balance, steady state-steady flow energy equation, important applications-Nozzle and diffusor, throttling device, turbine and compressor, heat exchanger.

Unit V

Second Law of Thermodynamics: Thermal reservoirs, Devices- heat engine, heat pump and refrigerator -schematic representation and efficiency. Kelvin-Planck statement and Clausius statement of Second law of thermodynamics; PMM1 and PMM2, Reversible and irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. Thermodynamic temperature scale. **Air Standard Cycle:** Efficiencies of Otto cycle, Diesel cycle, Dual cycle, Brayton cycle. **Heat Transfer:** Basic applications of conduction, convection and radiation.

Text Books

1. Fluid Mechanics by Dr. Bansal. RK Lakshmi publications, 4th edition 2011
2. Fluid Mechanics by streeter, 1st edition 2005
3. Fluid Mechanics and hydraulics, by Jagadishlal, Metropolitan book co-Ltd 4th edition 2004
4. P.K. Nag –Basic and Applied Thermodynamics, Tata McGraw Hill, 3rd Edition. 2003
5. Yunus A. Cenegal and Michael A. Boles –Thermodynamics an engineering approach, Tata McGraw hill Pub. 2006
6. Rajput –Engineering Thermodynamics, Laxmi Publication pvt ltd., 3rd Edition. 2007.

Reference books

1. Fluid Mechanics by Modi and Seth, 5th edition 2004
2. Engineering Fluid Mechanics by Dr. K.L. Kumar, revised edition 2009.S Chand & Co
3. Fluid Mechanics and fluid power Engineering by Kumar .D.S, Kataria & Sons, 2nd edition 2004.
4. J.B. Jones and G.A. Hawkin –Engineering Thermodynamics, John Wiley and Sons.
5. S.C. Gupta –Thermodynamics, Person Edu. Pvt. Ltd., 1st Edition, .2005.

Course outcomes (COs):

At the end of the course, students will be able to

1. Understand the basic principles and applications of properties of fluid and fluid statics. (PO-1,2,3&PSO1)
2. Apply basic concepts of fluid dynamics, friction in pipe flows, fluid flow measurements (PO:1,2,3,4& PSO1)
3. Apply the concepts of heat and work in thermodynamics devices. (PO:1, 2& PSO1, 2)
4. Apply the first laws to the thermodynamic system. (PO-1, 2, 3& PSO1, 2)
5. Solve engineering problems by utilizing laws of thermodynamics in devices. (PO-1, 2, 3& PSO1, 2)

WORK STUDY AND ERGONOMICS

Course Code: IM36 **Credit:3: 0: 0**
Pre requisite: Nil **Course Hours: 42**
Course Coordinator(s): V.Vivekanand/ Dr.S.Appaiah

Course Content

Unit I

Productivity: Definition of productivity, individual enterprises, task of management Productivity of materials, and, building, machine and power. Measurement of productivity (labor, material, multifactor), factors affecting the productivity.
Work Study: Definition, objective and scope of work study. Human factor in work study Work study and management, work study and supervision, work study and worker.

Unit II

Introduction to 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 movements, two handed process chart, SIMO chart, and micro motion study. Development, definition and installation of the improved method**.**

Unit III

Introduction to Work Measurement: Definition, objective and benefit of work measurement. Work measurement techniques. Work sampling: need, confidence levels, and sample size determinations, with simple problems.
Time Study: Time Study, Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information.

Unit IV

Time Study (Contd...): Rating, Systems of rating. Scales of rating, factors affecting rate of working, Allowances and Standard time determination: (Problems with no machine allowance, with machine allowance). Predetermined motion time study – Method time measurement: MTM1, MTM2, MTM3, MOST

Unit V

Ergonomics: Introduction, areas of study under ergonomics, man-machine system. Components of man-machine system and their functions –, study of development of stress in human body and their consequences. Computer based ergonomics. Usability Engineering and Human Computer interface**.**

Design of man-machine system: Quantitative, qualitative representation and alphanumeric display. Design of work places, Influence of climate on human efficiency. Influence of noise, Vibration and Light on human efficiency

Text Books

1. Geroge Kanawaty - ILO -Introduction to work study, ISBN 13:9788120406025 Publisher: India Book House Pvt. Ltd, 4th Revised Edition, 2008.
2. M.P. Groover-Work Systems: The Methods, Measurement & Management of Work, ISBN: 978-93-325-8124-1, Pearson, 1st Edition, 2013.
3. Ralph M Barnes -Motion and Time study, ISBN: 13:978981426182 Publisher: John Wiley, 7th edition 2009.

References

1. Andris Freivalds and Benjamin Niebel - Niebel's Methods, Standards, & Work Design, ISBN-13: 978-0073376318, Mc Graw Hill, 13th Edition, 2014
2. M S Sanders and E J McCormic -Human Factors in Engineering Design, ISBN: 13:9780070549012, Mc Graw Hill, 7th Edition.
3. William Stevenson, Operations Management, ISBN: 13: 978-9353163419, McGraw Hill Education; 12th edition.

Course outcomes (COs):

At the end of the course, students will be able to

1. Identify areas where there would be a need for improvement of productivity, reduction of ineffective time in an organization. (PO-1,2,3,5 & PSO1)
2. Analyze and Develop method study techniques and use the correct set of method study techniques, tools for a given scenario (PO-2,3,5& PSO2)
3. Determining sample size based on work sampling study and understanding time study concepts. (PO:1,2,5& PSO2)
4. Apply the tools and techniques of work study in order to measure the rate of working and establish standard time for simple and complex process (PO-1,2,5& PSO2)
5. Design and develop the man machine system and its function in industry, society and areas where the effect of such a system can be created. (PO-1,2,5& PSO3)

MATERIALS TESTING LAB

Course Code: IML37 **Credit:0: 0: 1**
Pre requisite: Nil **Contact Sessions:14**
Course Coordinator(s): A. Balakrishna / Sudheer D. Kulkarni

Course Content

List of experiments

I Destructive testing

1. Tensile test – On metallic specimens
2. Compression test
3. Torsion test
4. Bending test on metallic & nonmetallic specimen
5. Shear Test – Single and Double Shear
6. Izod& Charpy impact tests
7. Brinnel Hardness test of different metallic specimen
8. Rockwell & Vickers hardness test on metallic specimen
9. Wear test using pin on disc wear testing machine

II Nondestructive testing

1. Ultrasonic flaw detection
2. Magnetic particle test
3. Dye penetrate test

} Demonstration only

III Preparation of specimen for metallographic examination of different Engg. Materials.

1. Identification of microstructure of plain carbon steel, tool steel
2. Identification of microstructure of grey cast iron, SG iron, Brass, Bronze & Composites.

Text Books

1. Basavarajaiah and Mahadevappa, Strength of Materials, University Press, 2010
2. Ramamrutham, Strength of Materials, Dhanapath Rai Publishers, 2008.

References

1. L.S.Srinath, Prakash Desai and AnanthRamu -Strength of Materials, TMH Publishers, Chennai, 2008.
2. S.S Bhavikatti -Strength of Materials, Vikas Publications House pvt. Ltd, 3rd edition 2009
3. Timoshenko and Young -Elements of Strength of Materials, Affiliated East-West Press, 2nd edition 2007

Course outcomes (COs):

At the end of the course, students will be able to

1. Suggest appropriate material for practical applications with the knowledge of their mechanical and wear properties. (PO-3,4& PSO1)
2. Identify the various materials and their composition by the study of the microstructure. (PO-3,4& PSO1)

WORK STUDY AND ERGONOMICS LAB

Course Code: IML38 **Credit:0: 0: 1**
Pre requisite : Nil **Contact Sessions:14**
Course Coordinator (s) : V.Vivekanand / Dr.S.Appaiah

Course Content

List of Experiments

1. Construction of Outline Process Chart for simple assembly
2. Recording the given activity using Flow Process Chart (Men/Material/Equipment)
3. Constructing the String Diagram for a shop-floor activity
4. Construction of Two Handed Process Chart for pin board assembly
5. Rating practice using walking simulator
6. Rating practice for dealing a deck of cards
7. Rating Practice for pin board assembly
8. Rating Practice for marble experiment
9. Determination of standard time for simple operations using stop watch method
10. Determination of standard time for simple operations using Predetermined time standards
11. Measurement of parameters (heart beat rate, calorie consumption) using walking simulator
12. Measurement of parameters (heart beat rate, calorie consumption, revolutions per minute) using ergometer
13. Designing a Chair using anthropometry principles
14. Effect of noise, light and heat on human efficiency in work environment.

Text Books

1. GerogenKanawaty - ILO -Introduction to work study, ISBN 13:9788120406025 Publisher: India Book House Pvt. Ltd, 4th Revised Edition, 2008.
2. M.P.Groover-Work Systems: The Methods, Measurement & Management of Work, ISBN: 978-93-325-8124-1, Pearson, 1st Edition, 2013.
3. Ralph M Barnes -Motion and Time study, ISBN: 13:978981426182 Publisher: John Wiley, 7th edition 2009.

References

1. AndrisFreivalds and Benjamin Niebel - Niebel's Methods, Standards, & Work Design, ISBN-13: 978-0073376318, Mc Graw Hill, 13th Edition, 2014

2. M S Sanders and E J McCormic - Human Factors in Engineering Design, ISBN: 13:9780070549012, Mc Graw Hill, 7th Edition.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Identify areas where work study tools and techniques can be applied (PO-1,3 & PSO 1,2)
2. Apply the tools and techniques to various simulated scenarios and real life problems in industry and society (PO-1,3& PSO1,2)
3. Create novel designs of work place and other areas where improvement can be applied with perspective of various constraints faced in real life situation at society and industry level (PO-1,3& PSO1,2,3)

ADDITIONAL MATHEMATICS – I

Course Code: AM31 **Credit:0: 0: 0**
Pre requisite : Nil **Contact Hours: 40L**
Course Coordinator (s) : Dr. N L Ramesh

Course Objectives:

The students will

1. Learn successive differentiation, polar coordinate system and Taylor's series expansion of functions of single variable.
2. Learn the concept of reduction formula and multiple integrals.
3. Study vector algebra and vector differentiation.
4. Learn the procedure of solving first order and first degree ODE's.

Unit-I

Differential Calculus-I -08 Hrs

Successive differentiation, n^{th} derivatives of some standard functions, Leibnitz theorem, Polar curves. Angle between the radius vector and the tangent, angle between curves, length of the perpendicular from pole to the tangent, pedal equations. Taylor's and Maclaurin's expansions.

Unit-II

Integral Calculus -08 Hrs

Introduction, Reduction formula, Reduction formula for $\int sin^n x\, dx$, Reduction formula for $\int cos^n x\, dx$, Reduction formula for $\int sin^n x cos^m x\ dx$, Evaluation of double and triple integrals.

Unit-III

Vector Algebra-08 Hrs

Scalar and vectors. Vector addition and subtraction. Multiplication of vectors (Dot and Cross products). Scalar and vector triple product-simple problems. Vector functions of a single variable. Derivative of a vector function, geometrical interpretation. Velocity and acceleration.

Unit –IV

Vector Differentiation-08Hrs

Scalar and vector fields, gradient of a scalar field, directional derivative, divergence of a vector field, solenoidal vector, curl of a vector, irrotational vector,Laplace's operator. Vector identities connected with gradient, divergence and curl.

Unit- V

First Order Differential Equations-08 Hrs

Solution of first order and first degree differential equations, variable separable methods, homogeneous equations, linear and Bernoulli's equations, exact differential equations.

Text Books:

1. B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 44thedition, 2017.
2. Erwin Kreyszig –Advanced Engineering Mathematics, Wiley publication, 10th edition, 2015.

References:

1. H.K. Dass – Higher Engineering Mathematics – S Chand Publications - 1998.
2. B.V. Ramana – Engineering Mathematics – Tata McGrawHill Publishing Co. Ltd. – New Delhi – 2008.

Course Outcomes (COs):

At the end of the course the student will be able to

1. Find the length of the perpendicular from pole to tangent and determine the series expansion of differentiable functions (PO-1, 2)
2. Evaluate multiple integrals (PO-1, 2)
3. Analyze and solve problems related to Vector Algebra. (PO-1, 2)
4. Apply vector differentiation to identify solenoidal and irrotational vectors. (PO-1, 2)
5. Solve the first order and first degree ordinary differential equations. (PO-1, 2)

IV Semester

ENGINEERING MATHEMATICS-IV

Course Code: IM41 **Credit:3: 1: 0**
Prerequisite: Calculus **Contact Hours: 42L+ 14T**
Course Coordinators: Dr. Dinesh P A

Course Objectives

The students will

1. Learn the concepts of finite difference, interpolation and their applications.
2. Learn the concepts of Fourier and Z – transforms.
3. Understand the concepts of PDE and their applications to engineering.
4. Understand the concepts of Graph theory, matrix representation of graphs and their applications to Engineering with algorithms.

Course Content

Unit I

Finite Difference and Interpolation: Forward, Backward differences, Interpolation, Newton's – Gregory Forward and Backward Interpolation formulae, Lagrange's interpolation formula and Newton's divided difference interpolation formula (no proof).

Numerical Differentiation and Numerical Integration: Derivatives using Newton's – Gregory forward and backward interpolation formulae, Newton – Cote's quadrature formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule.

Unit II

Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Properties, Inverse transforms, Convolution theorem, Parseval's identities (statements only), Limitations of Fourier transform and needs of Wavelet transform.

Z-Transforms: Definition, Standard Z – transforms, Single sided and double sided, Linearity property, Damping rule, Shifting property, Initial value and Final value theorems, Inverse Z – transforms, Application of Z – transforms to solve difference equations.

Unit III

Partial Differential Equations and its Solutions using Finite Difference Method: Classification of second order PDE, Derivation of one – dimensional heat and wave equations, Solution of one dimensional heat equation using implicit and explicit methods, one dimensional wave equation using explicit method & two dimensional Laplace and Poisson equations.

Unit IV

Graph Theory - I: Introduction - Finite and Infinite graphs, Incidence and Degree, Isolated vertex, Pendant vertex and Null graph, Operations on graphs, Walk, Paths and Circuits. Connected graphs, Disconnected graphs and Components. Euler and Hamiltonian graphs, Trees – Properties of trees, Pendant vertices in a tree, Distance and centers in a tree, Rooted and binary trees, Spanning trees, Kruskal's and Prims algorithm to find the minimal spanning tree.

Unit V

Graph Theory - II: Matrix representation of graphs: Adjacency matrix, Incidence matrix, Rank of the incidence matrix, Path matrix, Circuit matrix, Fundamental circuit matrix, Rank of the circuit matrix, Cut-set matrix, Fundamental cut-set matrix, Relationships among fundamental incidence, circuit and cut-set matrices.

Text Books

1. Erwin Kreyszig – Advanced Engineering Mathematics – Wiley publication – 10th edition – 2015.
2. B. S. Grewal – Higher Engineering Mathematics – Khanna Publishers – 44th edition – 2017.
3. Narsingh Deo – Graph Theory with Applications to Engineering and Computer Science – Prentice Hall of India – 2014.

References

1. Glyn James – Advanced Modern Engineering Mathematics – Pearson Education – 4th edition – 2010.
2. Dennis G. Zill and Michael R. Cullen – Advanced Engineering Mathematics, Jones and Barlett Publishers Inc. – 3rd edition – 2009.
3. Reinhard Diestel – Graph Theory – Springer - 4th edition – 2010.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Find functional values, derivatives, areas and volumes numerically from a given data. (PO-1,2& PSO1,2)
2. Evaluate Fourier transforms and use Z – transforms to solve difference equations. (PO-1,2& PSO1,2)
3. Solve partial differential equations numerically. (PO-1,2& PSO1,2)
4. Identify different types of graphs and determine minimal spanning tree of a given graph using algorithms. (PO-1,2& PSO1,2)
5. Analyze characteristics of a graph through its matrix representations. (PO-1,2 & PSO1,2)

MECHANICAL MEASUREMENTS AND METROLOGY

Course Code: IM42 **Credit:4: 0: 0**

Pre requisite : Nil **Contact Hours: 56**

Course coordinator: Dr. M R Shivakumar / Dr. R Shobha

Course Content

Unit I

Standards of Measurement: Definition and objectives of metrology, Standards-standards of length, International prototype meter, Wavelength standard. Slip gauges-Wringing phenomena, Numerical problems on building of slip gauges.

Measurements and Measurement System: Definition, Significance of measurement, generalized measurement system. Definition and concept of accuracy, precision, sensitivity, calibration, threshold. Concepts of hysterics, repeatability, Linearity. Loading effect, Errors in measurement, classification of errors

Unit II

Systems of Limits, Fits, Tolerances and Gauging Introduction, Definition of Tolerance, Principle of Inter changeability and selective assembly, concepts of limits of size and tolerance, definition of fit, Different types of fit, Hole basis system and shaft basis system. Introduction to gauges, classification of gauges, design of gauges using Taylor's Principle. Introduction to surface roughness.

Comparators: Need of comparator, characteristics, classification and advantages, Dial gauge, Johansson Mikrokator, Sigma Comparator, Zeiss Ultra –Optimeter.

Unit III

Angle measurements and interferometry: Introduction, sine bar- principle of sine bar, Errors in sine bar. Principle of interferometry, optical flat, principle of autocollimator.

Screw thread and gear measurement: Terminology of screw threads. Measurement of major diameter, minor diameter and effective diameter by 2 – wire method of screw thread. Profile projector – working principle. Tool maker's microscope – construction and working principle. Gear terminology, Parkinson's gear tester – construction,

Measurement using Co-ordinate Measuring Machine -Features of CMM, performance of CMM, application and advantages CMM.

Unit IV

Transducer and Torque measurement: Introduction, classification of transducers, primary and secondary transducers**,** mechanical transducers-mechanical springs, pressure sensitive elements, Electrical transducers- resistive transducers, LVDT. Torque measurement, types.

Acceptance test on lathe and drilling machine.

Measurement of Force, and pressure: Introduction, Analytical balance, Platform balance. Proving ring – sketch and working principle. Drill tool dynamometer and lathe tool dynamometer. Basic bourdon tube, Elastic diaphragms. Bridgman gauge – Sketch and working principle. McLeod Vacuum gauge – working principle.

Unit V

Temperature and Strain Measurement: Introduction, Resistance thermometers – sketch and working principles, Thermocouple, Optical Pyrometer. Strain gauges – mechanical strain gauge, optical strain gauge, Electrical resistance strain gauges-bonded type. Basic Wheatstone Resistance Bridge,

Thermal property measurement – Thermal conductivity and thermal expansion

ISO: Concepts and Practices: Introduction, What is system? , Summery of elements of ISO 9001, Advantages of Adopting ISO 9000, Registration of ISO 9000, Validity of registration, preparation, organizing documentation and metrological requirements of ISO 9000 standards.

Text Books

1. R K Jain, Engineering Metrology, Khanna publications,8th edition, 2002,
2. Beckwith -Margangoni and Lienhard – Mechanical Measurements, Prentice Hall Publishers, 6th edition, 2006.
3. I.C. Gupta -Engineering Metrology, Dhampat Rai Publications, 7th edition, 2013.

References

1. Sirohi and Radhakrishna -Mechanical Measurements, Newage International publication, 2nd edition, 1991.
2. Doebelin –Measurement System, TMH,5th edition, 2003.
3. ALsutko Jerry D. Faulk -Industrial Instruments, Thompson Asia Pvt. Ltd. -2002.

Course outcomes (COs):

At the end of the course, students will be able to

1. Apply the concepts of metrology and measurements in industries. (PO-1,3 & PSO1)
2. Design the inspection gauges. (PO-1,2,3 & PSO1)
3. Use the metrology instruments in angle measurements, screw thread measurements, gear measurements and measurement using CMM. (PO-1,2,5 & PSO1,2)
4. Understand use of transducers in measurements and working of Torque, force and pressure measuring instruments. (PO-1,2,5 & PSO1,2)
5. Understand the concept of temperature and strain measurement, Thermal properties measurements, and able to develop and maintain ISO procedure in metrology and measurements. (PO-5,6,10) (PSO1,2,3)

MACHINE TOOL TECHNOLOGY

Course Code: IM43 **Credit:4: 0: 0**
Pre requisite : Nil **Contact Hours: 56**
Course Coordinator(s): Sudheer D. Kulkarni / Dr. R. Shobha

Course Content

Unit I

Theory of Metal Cutting: Single point tool nomenclature, geometry, orthogonal & oblique cutting, mechanism of chip formation, types of chips, Merchants analysis, Ernst-Merchant's solution, shear angle relationship, problems on Merchants analysis
Selection of Cutting Tool Materials: Desired properties, types of cutting tool materials- HSS carbides, coated carbides, ceramics; Cutting Fluids- properties, types & selection, machinability, factors affecting machinability.
Tool Wear & Tool Failure: Effects of cutting parameters, Tool life criteria, Taylor's tool life equation, problems on tool life evaluation

Unit II

Production Lathes: Capstan & Turret lathes-constructional features, tool & work holding devices, tool layout
Drilling Machines: Classification, constructional features, drilling & related operations, types of drill & drill bit nomenclature. Numerical Problems on calculation of machining time

Unit III

Reciprocating Machine Tools:
Shaper- Classifications, constructional features, Specification of shaper, Shaper Mechanisms, Types, Hydraulic shaper. Cutting Speed, Feed, Depth of cut & machining time-Various shaper operations; tool & work holding devices, Numerical problems on calculation of machining time
Introduction to Planer -Principal parts and working of Double housing Planer
Principal parts of Slotter-Working of slotter

Unit IV

Milling Machines: Classification, constructional features, milling cutters & nomenclatures, milling operations, up milling & down milling concepts.
Indexing: Purpose of indexing, simple, compound, differential and angular indexing calculations
Grinding Machines: Types of Abrasives, Bonding process, classification, constructional features, Surface, cylindrical &centre less grinding operations

Unit V

Non - Traditional Machining Processes: Principle, equipment, operation, applications of following processes; Electric discharge machining, wire cut EDM, Electrochemical machining, Ultrasonic machining, Laser beam machining, Abrasive jet machining, Water jet machining, Electron beam machining.

Micromanufacturing: Introduction, Semiconductors and Silicon, Crystal Growing and Wafer Preparation, Films and Film Deposition, Oxidation, Lithography, Etching, Diffusion and Ion Implantation, Metallization and Testing, Wire Bonding and Packaging, Printed Circuit Boards

Text Books

1. Serope Kalpakjian and Steven R. Schniid - Manufacturing Processes for Engineering MaterialsTechnology, Pearson Education Asia, 5th Edition. 2015.
2. R Rao, P.N., Manufacturing Technology, Vol I & II, Tata Mcgraw Hill Publishing Co., New Delhi, 1998
3. Amitabha Ghosh & Mallik -Manufacturing science, Affiliated East West press, 1995
4. HMT -Production Technology, Tata McGraw Hill, 2001

Reference Books

1. John. A. Schey -Introduction to Manufacturing Processes, McGraw Hill, 3rd Edition, 2001.
2. Pandey & Shah -Modem machining process, TMH, 2000.
3. B J Ranganath -Metal Cutting and tool design, Vikas Publications.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Apply the concept of metal cutting operations and the forces acting during metal cutting and estimate the tool life (PO-1,2, 6& PSO1)
2. Familiarize the usage and applications and operations of various machine tools like lathe and drilling machines (PO-1,2& PSO1)
3. Understand the various operations and application of shaper and planer machines (PO-1,2& PSO1)
4. Apply the indexing methods to solve industrial problems and to understand the importance of milling and grinding machines (PO-1,2& PSO1)
5. Appreciate the application of modern machining methods and understand various micromachining methods (PO-1, 6, 7& PSO1)

MATERIALS MANAGEMENT

Course Code: IM44 **Credit:4: 0: 0**
Pre requisite : Nil **Contact Hours: 56**
Course coordinators: P R Dheeraj / V Vivekanand

Course Content

Unit I

Inventory Fundamentals: Operating Environment. Material Flow. Aggregate Inventory Management. Item Inventory Management. Inventory and Flow of Material. Supply and Demand Patterns. Functions of Inventories. Objectives of Inventory Management. Inventory Costs.

Unit II

Purchasing: Supply Chain Concept. Supply Chain Metrics. Establishing Specifications. Functional Specification Description. Selecting Suppliers. Price Determination. Impact of MRP on Purchasing. Organisational Implications of SCM.

Unit III

Order Quantities: Financial Statements and Inventory. Making the Production Plan. ABC Inventory Control. Economic Order Quantity (EOQ). Variations of EOQ Model. Quantity Discounts. Use of EOQ when Costs are not known. Period Order Quantity (POQ).

Unit IV

Independent Demand Ordering Systems: Order Point System. Determining Safety Stock. Determining Service Levels. Different Forecast and Lead Time Intervals. Determining when Order Point is reached. Periodic Review System. Distribution Inventory.

Unit V

Physical Inventory and Warehouse Management: Warehousing Management. Physical Control and Security. Inventory Record and Accuracy.
Physical Distribution: Physical Distribution System. Interfaces. Transportation. Legal Types of Carriage. Transportation Cost Elements. Warehousing. Packaging. Materials Handling. Multi-Warehouse Systems.

Textbook

1. Steve Chapman & Tony Arnold – Introduction to Materials Management, Pearson, 2016.

References

1. P Gopalakrishna & M Sundaresan – Materials Management: An Integrated Approach, PHI, 2012.
2. A K Dutta – Materials Management: Procedures, Text and Cases, PHI, 2009.
3. S D Sharma – Operations Research, 4th edition, 2009.
4. Kanti Swaroop – Operations Research, S Chand, 2001.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Identify the fundamental concepts of materials management. (PO-1,2,3 & PSO1,2)
2. Design a basic purchasing system. (PO-1,2,3& PSO1,2)
3. Design basic inventory control systems. (PO-1,2,3& PSO1,2)
4. Design advanced inventory control systems. (PO-1,2,3& PSO1,2)
5. Design a basic warehousing system. (PO-1,2,3& PSO1,2)

MECHANISMS AND MACHINE DESIGN

Course Code: IM45 **Credit:3: 1: 0**
Pre requisite : Nil **Contact Hours: 56**
Course Coordinator(s): A. Balakrishna / Hamritha S

Course Content

Unit I

Introduction, Kinematic chain and Inversions: Definitions, Link or element, kinematic chain, mechanisms, inversion, machine, grubler's criterion mobility of mechanisms, four bar chain, single slider crank chain & double slider crank chain & their inversions.

Kinematic mechanisms: Quick return motion mechanism –Whitworth mechanism intermittent motion mechanism – Geneva mechanism, Pantograph, Ackerman's steering gear mechanism, condition for correct steering.

Unit II

Balancing of Machinery: Balancing of rotating masses: Balancing of several masses in the same plane, balancing of masses rotating at different planes – Analytical method. Tabular Column method.

Gyroscope: Vectorial representation, right hand thumb rule, gyroscopic couple. Gyroscopic effect on aero plane, gyroscopic effect on ship. Gyroscopic effect on two wheelers

Cams: Types of cams, followers. Displacement, velocity and acceleration time curves for cam profiles, follower motions including SHM, Uniform velocity, uniform acceleration & retardation and cycloidal motions.

Unit III

Design for Static Strength and Impact strength: Static strength; Static loads and factor of safety; Theories of failure -Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Stress concentration, Determination of Stress concentration factor.

Variable Stresses in machine parts: Fatigue strength, S -N diagram, cyclic loading, High cycle fatigue, Endurance limit, effect of loading on endurance limit. Modifying factors -size effect, surface effect, Stress concentration effects; fatigue stress concentration factors, combined steady and fluctuating stresses, Goodman's and Soderberg's relationship.

Unit IV

Design of springs: Types of springs -stresses in coil springs of circular cross sections. Tension and compression springs. Fluctuating load, Leaf springs. Stresses in Leaf springs. Equalized stresses in leaf springs.

Design of Mechanical Joints: Riveted Joints -Types, rivet materials, Failures of

Riveted joints (Problems on Longitudinal joints only), Welded Joints -Types, Strength of butt and fillet welds. Eccentrically loaded welds. Cotter joint and knuckle joints.

Unit V

Design of Gears and gear trains: Introduction to Spur gears. Design of spur gear, Lewi's equation, Lewi's form factor- dynamic and wear load.
Types of gear trains, problems on simple, compound and epicyclic gear trains, tabular column method only.

Text Books

1. Shigley, Joseph Edminister -Theory of Machines, Oxford University press 2011.
2. Sadhu Singh -Theory of Machines, Pearson Education, 2008.
3. R. S. Khurmi & J. K. Gupta -Theory of machines, Eurasia Publishing House, 2008
4. Joseph Edward Shigley -Mechanical Engineering Design, Tata McGraw Hill, 7th edition, 2008.
5. Robert. L. Norton -Machine Design, Pearson Education Asia, 3rd edition, 2009.

Design Data Hand Books

1. K. Lingaiah -Design Data Hand Book, Suma Publications, 2nd edition 2006, Vol.l & Vol.2.

References

1. Thomas Bevan -Theory of Machines, Pearson – 2011
2. Ballaney -Theory of Machines, Khanna Publication – 2003
3. R S Khurmi and J K Gupta -A text book of Machine Design, Eurasia Publishing House, 13th edition, 2005.
4. V B Bahandri – Design of Machine Elements, Tata McGraw Hill publishing co, Ltd., 2nd Edition, 2008.
5. R. K. Jain -Machine Design, Khanna Publications,.2nd edition, 2002.
6. JBK Das & P L Srinivasmuthy -Design of Machine Elements Volumes I & II, Sapna book house, 2nd edition, 2012.

Course outcomes (COs):

At the end of the course, students will be able

1. Determine the mobility of kinematic mechanisms and understand their applications. (PO-1, 2& PSO1)
2. Analyze the rotating masses and determine the balancing forces in a machine. (PO-1, 2, 3& PSO1, 2)

3. Apply the gyroscopic principles and effects on aeroplane, ship and two wheeler and designing of CAMS (PO-1, 2, 3& PSO1, 2)
4. Design liquid proof riveted/welded joints taking into account the efficiency of the joint and design of springs based on applications. (PO-1, 2, 11& PSO1)
5. Design suitable sized gears as per the standard design procedure and also test for safety of design and apply the law of gearing and determine the suitable gear train combination based on the application. (PO-1, 2, 3, 11& PSO1, 2)

FACILITIES PLANNING AND DESIGN

Course Code: IM46 **Credit:3: 0: 0**
Pre requisite : Nil **Contact Hours: 42**
Course Coordinator(s): Dr M. Rajesh / Dr. M. Shilpa

Course Content

Unit I

Plant Location and layout: Factors influencing plant location, location economics - problems. Objectives of plant layout, Principles of plant layout. Line Balancing. – Problems.

Unit II

Material Handling : Objectives and principles of Material handling, Unit load concept, classification and types of material handling equipment, Muther's Systematic Layout Planning procedure – problems.

Unit III

Space Determination and Area Allocation: Factors for consideration in space planning, area allocation factors to be considered, Sequence demand Straight line and non-directional methods – Analytical treatment**.** Determination of manpower and equipment requirement, use of travel chart for layout planning, analytical treatment.

Unit IV

Layout Evaluation: Methods of constructing the layout, efficiency indices. Green technology for layouts.
Layout models: Single facility and multi facility location models, warehouse layout models, Warehouse design as per International standards.

Unit V

Computer Aided Layout: Introduction to CRAFT, COFAD, PLANET, CORELAP and ALDEP – Analytical treatment.

Text Books

1. James M Apple -Plant Layout and Material handling, 2nd Edition, John, Wiely and Sons.
2. Francies,R.L. and White,J.A-Facility layout and Location, Mc Graw Hill, 2nd edition.
3. Tompkins J A, White, Bozer and Tanchoco-A Facilities planning, John Wiley & Sons; 4th edition, 2010

References

1. Muther Richard -Practical Plant Layout, Mc Graw Hill-1955.
2. Sunderesh Heragu-Facilities Design, PWS Publishing Company, ISBN-0-534 - 95183.
3. James M Moore -Plant Layout Design, Mac Millan Co.1962 LCCCN61- 5204.

Course outcomes (COs):

At the end of the course, students will be able

1. Identify the optimal location and layout from the alternatives. (PO-2,3& PSO2)
2. Aware of the different types of modern material handling equipment's for their use in the industry. (PO-5& PSO1)
3. Enhance productivity of the organization by efficient usage of men, materials and equipment's. (PO-1,2& PSO3)
4. Evaluate the layout efficiency. (PO-1,4& PSO3)
5. Use computer algorithms to design plant layouts. (PO-5,11& PSO1)

MANUFACTURING PROCESSES LAB

Course Code: IML47 **Credit:0: 0: 1**
Pre requisite : Nil **Contact Sessions:14**
Course Coordinator(s): Sudheer D. Kulkarni / Dr. R. Shobha

Course Content

List of experiments & models

I Testing of Moulding Sand

1) Compression test
2) Shear test
3) Permeability test
4) Grain fineness test
5) Clay content test
6) Moisture content test

II Foundry practice

1) Preparation of moulds using two moulding boxes using split patterns
2) Preparation of moulds using two moulding boxes using single piece patterns
3) Preparation of moulds using two moulding boxes without patterns (i.e.with hand cutting)

III Forging operations

1) Preparation of square headed bolt
2) Preparation of Hexagonal rod
3) Preparation of Gib headed key

Text Books

1. P.N. Rao -Manufacturing Technology: Foundry Forming and Welding, 2nd edition., TMH, 2003
2. SeropeKalpakjian and Steuen.R.Schniid - Manufacturing Technology, Pearson Education Asia, 5th Edition. 2006.
3. E Paul Degarmo -Materials and Processes in Manufacturing, 8th edition, PHI, 2002.

References

1. Amitabha Ghosh and A K. Mallik -Manufacturing Science, East West press
2. Roy A Lindberg -Material and Processes of Manufacture, PHI Publishers, 4th edition, Pearson education, 2006.
3. Heine. Loper -Principle of Metal Casting, Phillip, Rosenthal, TMH.2001.

Course outcomes (COs):

At the end of the course, students will be able

1. Analyze the properties of the moulding materials and interpret the results (PO-1,7& PSO1)
2. Prepare the moulds as per the given drawings and specifications using the relevant materials (PO-1,7& PSO1)
3. Apply the manufacturing processes to form metal into various shapes as per the given drawing and specifications (PO-1,7& PSO1)

COMPUTER AIDED MACHINE DRAWING LAB

Course Code: IML48 **Credit:0: 0: 1**
Pre requisite: CAED Lab **Contact Sessions:14**
Course Coordinator(s): Dr. M. R. Shivakumar/Dr. M Rajesh

Course Content

PART - A

Introduction: Graphic interface software, 3D environment, basic commands of software and drawing standards.
Construction of simple machine parts: Conversion of orthographic views into 3D views of simple machine parts.

PART - B

Assembly Drawings (Part drawing should be given):
Screw jack
Plummer block (pedestal bearing)
Protected type flanged coupling
Knuckle joint

Text Books

1. A premier on computer aided engineering drawing-2007- VTU Publication Belguam.
2. K R Gopala Krishna -Machine drawing, Subhash Publications, 2006 Bangalore.
3. S Trymbakamurthy -A text book Computer aided machine drawing, CBS publisher, New Delhi 2006

Reference Books

1. N Siddeswar, P Kannaih, V V S Shastri -Machine drawing, Tata Mc Graw Hill, 2006.
2. N D Bhatt and V M Panchal -Machine drawing, Charotar Publishing House, 43rd edition, 2008.

Course outcomes (COs):

At the end of the course, students will be able

1. Apply drawing standards and construct 3D machine components. (PO-1,2,3,10& PSO1,2)
2. Create complex machine drawings. (PO-1,2,3,10& PSO1, 2)

ADDITIONAL MATHEMATICS – II

Course Code: AM41 **Credit:0: 0: 0**
Pre requisite : Nil **Contact Hours: 40L**
Course Coordinator(s): Dr. N L Ramesh

Course Objectives:

The students will

1. Understand the concept of partial derivatives, composite functions and Jacobians.
2. Learn to evaluate line, surface and volume integrals.
3. Learn to use Laplace transform method to solve initial and boundary value problems.
4. Learn the procedure of solving Linear differential equations with constant and variable coefficients.
5. Study the concepts of basic probability.

Unit-I

Differential calculus - 08 Hrs

Partial differentiation, Euler's theorem, total differential coefficient, differentiation of composite and implicit functions, Jacobian and Properties. Taylor's theorem for function of two variables, maxima and minima for functions of two variables.

Unit-II

Vector integration – 08 Hrs

Line integrals, surface integrals and volume integrals. Green's theorem, Stokes' and Gauss divergence theorem (without proof) and problems, orthogonal curvilinear coordinates.

Unit-III

Laplace transforms - 08 Hrs

Definitions, Laplace transforms of elementary functions, derivatives and integrals, periodic function, unit step function, inverse transforms, applications of Laplace transforms to solve differential equations.

Unit-IV

Higher Order Differential Equations - 08 Hrs

Higher order linear differential equations, method of variation of parameters, Cauchy's and Legendre's homogeneous differential equations.

Unit-V

Probability - 08Hrs

Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability-illustrative examples. Bayes theorem –examples.

Text Books:

1. B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 44thedition, 2017.
2. Erwin Kreyszig –Advanced Engineering Mathematics, Wiley publication, 10th edition, 2015.

References:

1. H.K. Dass – Higher Engineering Mathematics – S Chand Publications - 1998.
2. B.V. Ramana – Engineering Mathematics – Tata McGrawHill Publishing Co. Ltd. – New Delhi – 2008.

Course Outcomes (COs):

At the end of the course the student will be able to

1. Find Jacobian, extreme values and power series expansion of a function. (PO-1, 2)
2. Exhibit the interdependence of line, surface and volume integrals using integral theorems. (PO-1, 2)
3. Use the concept of Laplace transforms to solve initial and boundary value problems (PO-1, 2)
4. Solve Linear differential equations with constant and variable coefficients (PO-1, 2)
5. Demonstrate the understanding of axioms and rules of probability to solve problems. (PO-1, 2)