M.S. RAMAIAH INSTITUTE OF TECHNOLOGY

BANGALORE

(Autonomous Institute, Affiliated to VTU)

SYLLABUS

(For the Academic year 2016 – 2017)

III & IV Semester B.E.

Industrial Engineering and Management

History of the Institute:

M. S. Ramaiah Institute of Technology was started in 1962 by the late Dr. M.S. Ramaiah, our Founder Chairman who was a renowned visionary, philanthropist, and a pioneer in creating several landmark infrastructure projects in India. Noticing the shortage of talented engineering professionals required to build a modern India, Dr. M.S. Ramaiah envisioned MSRIT as an institute of excellence imparting quality and affordable education. Part of Gokula Education Foundation, MSRIT has grown over the years with significant contributions from various professionals in different capacities, ably led by Dr. M.S. Ramaiah himself, whose personal commitment has seen the institution through its formative years. Today, MSRIT stands tall as one of India's finest names in Engineering Education and has produced around 35,000 engineering professionals who occupy responsible positions across the globe.

History of 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 commenced in the year 2012. The department has been recognized as R&D center by VTU. The department has well modernized laboratories namely Industrial & Quality Engineering lab, Computer Lab and Metrology & Mechanical Measurement lab. The department highly qualified, motivated and result oriented faculty members. All the faculties 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 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 seminars & workshops for academicians as well as Industry personnel. The society of Industrial Engineering and Management, "**INDEMAN SOCIETY**" 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. Many sponsored research projects are executed which are sponsored by UGC, DST and VTU

Faculty List

Sl.No	Names of Faculty	Qualification	Designation
1	Dr. N.V.R Naidu	M.Tech, Ph.D	Principal and Professor
1	Dr. G.S. Prakash	B.E., M.Tech, Ph.D	Professor and Head
2	Sri. A. Balakrishna	B.E., M.Tech	Associate Professor
3	Sri. S. Appaiah	B.E., M.Tech	Associate Professor
4	Dr. C.S.Chethan Kumar	B.E., ME, MBA, Ph.D	Associate Professor
5	Dr. S. Bharath	B.E, M.S., Ph.D	Associate Professor
6	Dr. M. Shilpa	B.E., ME, Ph.D	Asst. Professor
7	Sri. M.R. Shivakumar	B.E., ME, (Ph.D)	Asst. Professor
8	Dr. R. Shobha	B.E., ME, Ph.D	Asst. Professor
9	Dr. M. Rajesh	B.E., MSC (Engg.), Ph.D	Asst. Professor
10	Sri. Sudheer. D. Kulkarni	BE, M.Tech, (Ph.D)	Asst. Professor
11	Sri. Vivekanand Venkataraman	BE, MS	Asst. Professor
12	Sri. Deepak Kumar	B.Tech, M.Tech, (Ph.D)	Asst. Professor
13	Sri. P.R. Dheeraj	B.E, M.Tech	Asst. Professor

Vision and Mission

The Vision of MSRIT: To evolve into an autonomous institution of international standing for imparting quality technical education.

The Mission of MSRIT: MSRIT shall deliver global quality technical education by nurturing a conducive learning environment for a better tomorrow through continuous improvement and customization.

Quality Policy

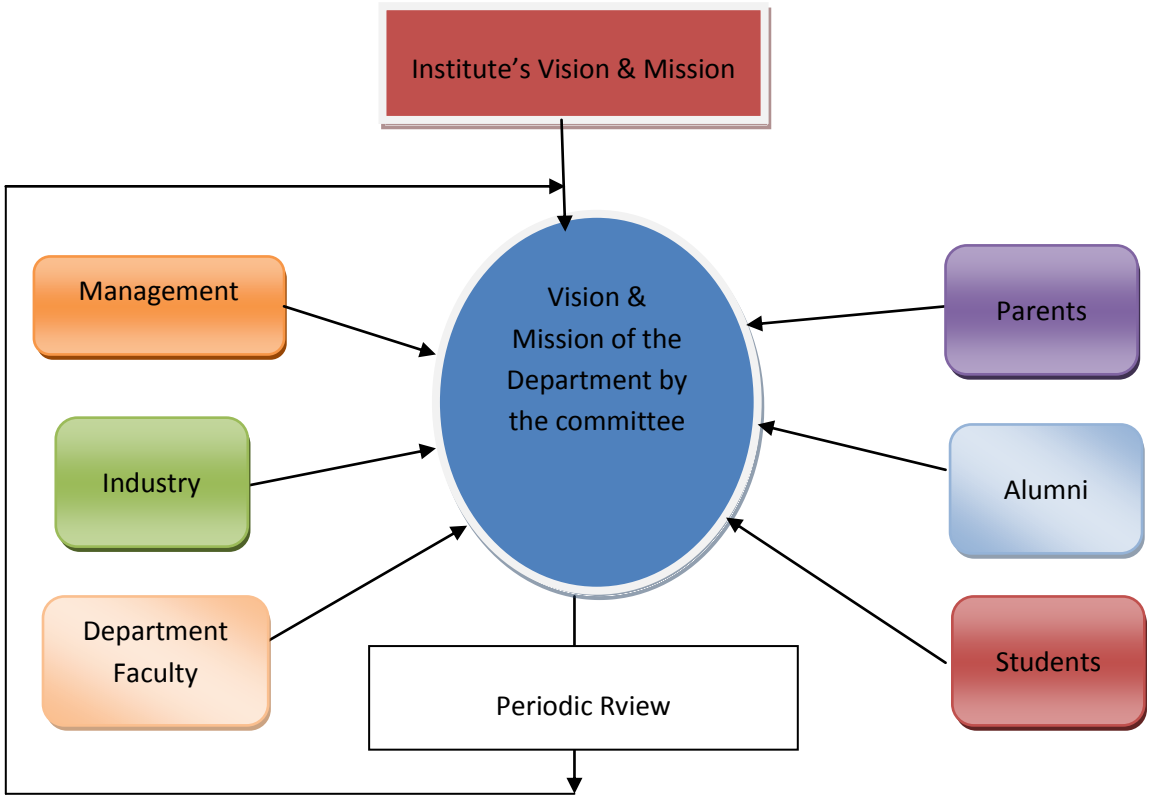
"We at M. S. Ramaiah Institute of Technology, Bangalore strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management system Complemented by the Synergistic interaction of the stake holders concerned".

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

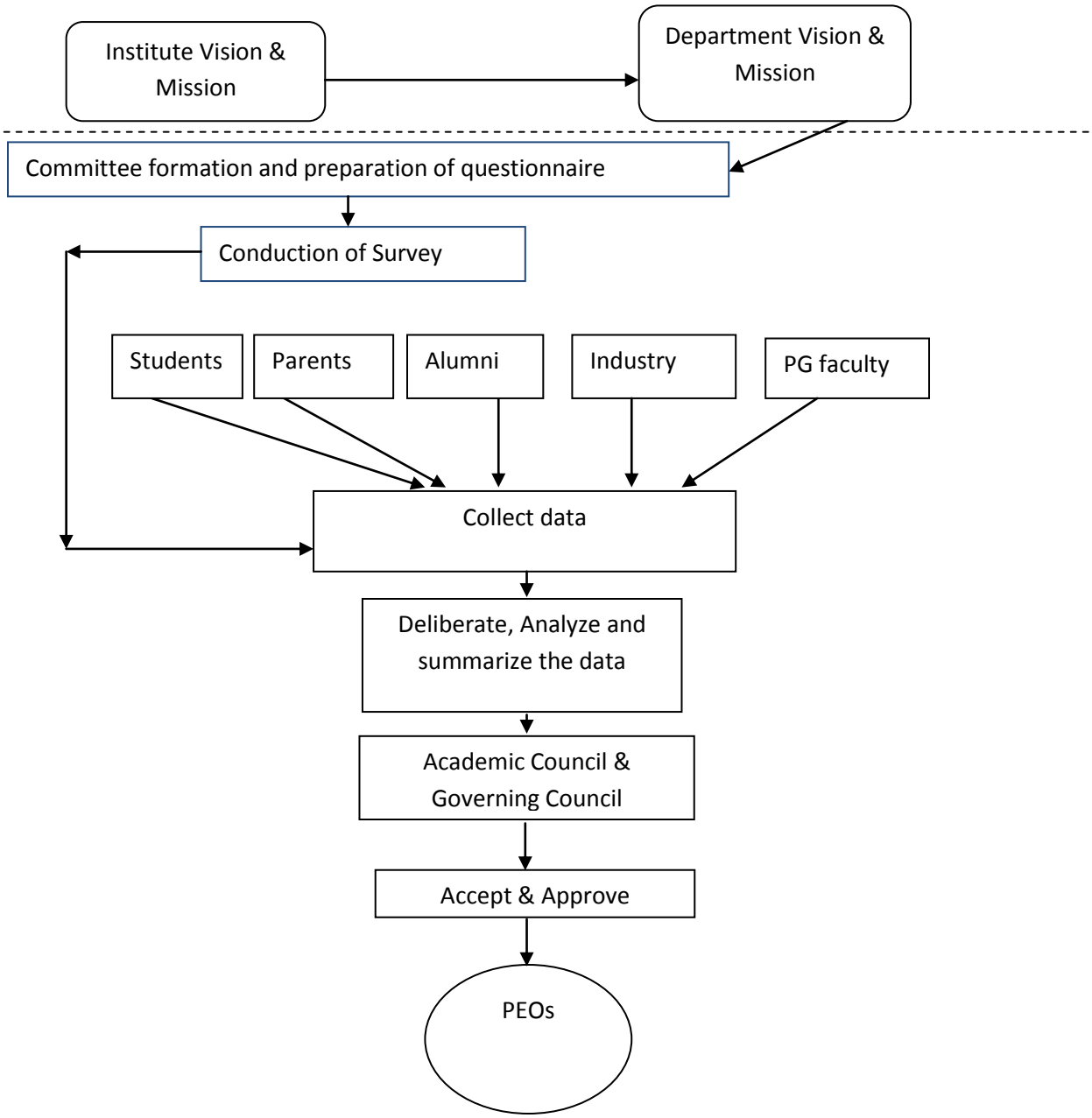
The Mission of the Department: The department shall transform the entrants of the Program into professionally competent engineers through innovative educational curricula, balanced research program and effective collaboration with industry and academia

Process of deriving the vision and mission of the department

Process of deriving the vision and mission of the department is shown in Figure below



Process of Deriving the PEOs of the programme



Programme Educational Objectives (PEOs) of the program

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.

Programme Outcomes (PO's) of the program offered

a. Apply knowledge and skills of mathematical and social sciences to the various industrial scenarios.
b. Design and conduct experiments, as well as analyze and interpret data.
c. Design and improve integrated systems of people, materials, information, facilities, and technology.
d. Function as a member of a multi-disciplinary team.
e. Identify, formulate and solve industrial and systems engineering problems.
f. Understand and respect professional and ethical responsibility.
g. Communicate effectively both orally and in writing.
h. Understand the impact of industrial engineering solutions in a global and societal context.
i. Recognize the need for and an ability to engage in life-long learning.
j. Have knowledge of contemporary issues in industrial and service sectors.
k. Use updated techniques, skills and tools of Industrial and system engineering throughout their professional careers.
l. Implement the concepts of project and financial management to satisfy customer expectations.

The Programme Specific Outcomes (PSO) of the Department of Industrial Engineering and Management programme are to produce graduates, who are able to,

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.

Mapping of PEO's with PO's and PSO's

The correlation between the Programme outcomes, Programme Specific outcomes and Program Educational objectives are mapped in the Table shown below:

Correlation between the POs and the PEOs

Sl. No.	Programme Educational Objectives	Programme Outcomes												PSO		
		a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
1	Apply the industrial engineering knowledge and skills to solve real life problems and interpret the results.	X	X			X						X			X	
2	Effectively design, implement, improve and manage the integrated socio-technical systems.	X	X	X	X			X				X	X	X		
3	Build and lead cross-functional teams, upholding the professional responsibilities and ethical values.				X		X	X					X			X
4	Engage in continuing education and life-long learning to be competitive and enterprising.								X	X	X	X			X	X

Curriculum breakdown structure:

The curriculum of Industrial Engineering & Management programme is so structured to include all the courses that together satisfy the requirements of the programme specific criteria prescribed by the **Institute of Industrial Engineers** (An American Professional Society) for the Baccalaureate level of Industrial Engineering programme and Engineering Management programme. The courses are grouped in line with the major components of the curriculum namely: (i) Mathematics and Basic sciences, (ii) Basic Engineering courses, (iii) Humanities and Social Sciences, (iv) Professional core courses, (v) Electives and (vi) industry exposure/internship.

Board of Studies for the Term 2015-2017

1. Head of the Department concerned:	Dr. G. S. Prakash, Professor and Head
2. At least five faculty members at different levels covering different specializations constituting nominated by the Academic Council	Dr. N.V.R. Naidu, Principal and Professor Sri. A Balaksishna, Associate Professor Sri. S. Appaiah, Associate Professor Dr. C.S. Chethan Kumar, Associate Professor, Dr. R. Shobha, Assistant Professor
3. Two experts in the subject from outside the college	Dr. M.S. Prabhuswamy, Professor, Department of Mechanical Engineering, SJCE, Mysore – 570006. Dr. S. S. Hebbal, Principal, PDA College of Engineering, Gulbarga-585102
4. One expert from outside the college, nominated by the Vice Chancellor	Dr. N. S. Narahari, Professor & Head, Dept of IEM, RVCE, Bangalore -560059.
5. One representative from industry/corporate sector allied area relating to placement nominated by the Academic Council	Sri. Prakash Viswanathan, Group Practice Head, Tech Mahindra, Bangalore – 560100
6. One postgraduate meritorious alumnus to be nominated by the Principal	Sri. V. Nanda kumar, Senior Consultant, DET- NORSKEVRITAS AS,No.25 FTI Colony, 12 Main, 4th Block, Nandini Layout, Bangalore -560096

M.S. RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE – 54
(Autonomous Institute, Affiliated to VTU)
SCHEME OF TEACHING FOR THE ACADEMIC YEAR 2016-2017 (2015 Batch)
III SEMESTER B.E. INDUSTRIAL ENGINEERING AND MANAGEMENT

Sl.No.	Subject Code	Subject	Teaching Department	Credits				
				L*	T*	P*	S*	Total
1	IMMAT31	Engg. Mathematics – III	Mathematics	**3**	**1**	**0**	**0**	**4**
2	IM32	Materials Science and Metallurgy	Industrial Engineering & Management	**4**	**0**	**0**	**0**	**4**
3	IM33	Work Study & Ergonomics	Industrial Engineering & Management	**4**	**0**	**0**	**0**	**4**
4	IM34	Manufacturing Technology	Industrial Engineering & Management	**3**	**0**	**0**	**1**	**4**
5	IM35	Mechanics of Materials	Industrial Engineering & Management	**3**	**1**	**0**	**0**	**4**
6	IMSC361	Basic Thermodynamics	Industrial Engineering & Management	**3**	**0**	**0**	**0**	**3**
	IMSC362	Fluid Mechanics						
7	IML37	Materials Testing Lab	Industrial Engineering & Management	**0**	**0**	**1**	**0**	**1**
8	IML38	Work Study and Ergonomics Lab	Industrial Engineering & Management	**0**	**0**	**1**	**0**	**1**
			Total	**20**	**2**	**2**	**1**	**25**

*** L :** Lecture ***T :** Tutorial ***P :** Practical ***S** : Self Study ***Sc** : Soft Core

* IMSC361- Basic Thermodynamics / IMSC362 - Fluid Mechanics (* Any one of the Two)

Engineering Mathematics – III

Course Code: IMMAT31 **Credits: 3 : 1 : 0 : 0**

Prerequisite : Nil **Contact Hours: 42+ 14 Tutorial Sessions**

Course Coordinator(s): M. Girinath Reddy

Course Objectives:

- Learn to solve algebraic, transcendental and ordinary differential equations numerically.
- Learn to fit a curve, correlation, regression for a statistical data.
- Learn to represent a periodic function in terms of sines and cosines.
- Understand the concepts of continuous and discrete integral transforms in the form of Fourier and Z-transforms.
- Understand the concepts of calculus of functions of complex variables.

Course Contents:

Unit I

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

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

Statistics: Curve fitting by the method of least squares, fitting a linear curve, fitting a parabola, fitting a Geometric curve**,** Correlation and Regression.

Unit II

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 III

Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, properties, Inverse transforms, Convolution theorem, Parseval identities (statements only).

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 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 $w = z^2$,

$w = e^z$ and $w = z + a^2/z$ $(z \neq 0)$, Bilinear transformation

Unit V

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

Text Books:

1. Erwin Kreyszig – Advanced Engineering Mathematics – Wiley publication – 10th edition-2015.
2. B. S. Grewal – Higher Engineering Mathematics – Khanna Publishers – 43rd edition – 2015.

References:

1. Glyn James – Advanced Modern Engineering Mathematics – Pearson Education – 4th edition – 2010.
2. Dennis G. Zill, Michael R. Cullen - Advanced Engineering Mathematics, Jones and Barlett Publishers Inc. – 3rd edition – 2009.
3. Dennis G. Zill and Patric D. Shanahan- A first course in complex analysis with applications- Jones and Bartlett publishers-second edition-2009.

Course Outcomes:
Students are expected to do the following

CO1: Should be able to solve the problems of algebraic, transcendental and ordinary differential equations using numerical methods **(PO:a,b,e,k) (PSO:2)**

CO2: Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data. **(PO:a,b,c,g) (PSO:3)**

CO3: Find the Fourier series expansion of a function in both full range and half range values of the variable and obtaining the various harmonics of the Fourier series expansion for the given numerical data. **(PO:a,b,c,f) (PSO:2)**

CO4: Find Fourier transforms, Fourier sine and Fourier cosine transforms of functions and solving difference equations using Z-transforms. **(PO:e,f,j,k) (PSO:3)**

CO5: Find singularities of complex functions and determine the values of integrals using residues. **(PO:a,b,c,e,h) (PSO:1)**

Materials Science and Metallurgy

Course Code: IM32 **Credits: 4 : 0 : 0 : 0**

Prerequisite: Nil **Contact Hours: 56**

Course Coordinator(s): M. Shilpa / R. Shobha

Course objectives:

- To introduce different types of crystal structures, their imperfections and effects
- To understand how and when materials fail and how to avoid these failures
- To construct the phase diagrams; identify different phases and appreciate their properties for various applications
- To understand how alloys can be strengthened depending upon the application
- To appreciate the developments of various alloys and select appropriate alloy for a given application

Course contents:

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 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 Developments

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 Nanomaterials in electronics, automobiles, textile, sports, domestic appliances, medicine and defence

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", John Wiley and Sons India Pvt Ltd., 9th Edition, 2014 New Delhi.
2. Smith -Foundation of Material Science and Engineering, 3rd Edition, Mc Graw Hill, 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.

References :

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
4. Pearson Prentice hall, New Jersey,2006.

Course outcomes:

The student will be able to

CO1: To identify the different types of crystal structures and imperfections present in them **(PO: c) (PSO1)**

CO2: To analyze how materials fail and how the failures can be reduced **(PO: c) (PSO1)**

CO3: To construct the phase diagrams and identify the different phases **(PO: c) (PSO1)**

CO4: To identify the right material strengthening mechanism for a given application **(PO: c, e) (PSO2)**

CO5: To analyze the requirements of the given application and then select the right material for it **(PO: c, e) (PSO2)**

Work study and Ergonomics

Course Code: IM33 **Credits: 4 : 0 : 0 : 0**

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

Course Coordinator (s): S. Appaiah / V.Vivekanand

Course Objectives:

- To understand the importance of the usage of work study at various sectors in an organization and its effectiveness in improvement of productivity
- To provide the usage of the various tools and techniques used in work study through various real time examples and simulated examples
- To enhance the usage of the tools and techniques by comparative study of the existing system with the proposed system
- To develop an ergonomic based design for Human Machine System, Work Places and Other areas Where human machine interaction are involved

Course contents

Unit I

Productivity: Definition of productivity, individual enterprises, task of management Productivity of materials, and, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs.

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, 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. Rating, Systems of rating.

Unit IV

Scales of rating, factors affecting rate of working, allowances and standard time determination. Predetermined motion time study – Method time measurement (MTM)

Wages and Incentives: Need for motivating through incentives, requirements of good wage incentive plan, system with workers earning, varying in proportion to output, proportionality less than output, proportionality more than output, proportionality differential output, such as straight piece system, Halsey system, Rowan system Barth system, Barth Bedaux system, High piece rate system, Taylor's differential piece rate system. Advantages ,disadvantages, Financial incentives, non-financial incentives.

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 displays. types of control, layouts of panels and machines. Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light on human efficiency.

Text Books:

1. ILO **-Introduction to work study**, ISBN 13:9788120406025 Publisher: India Book House Pvt. Ltd, 4th Revised Edition, 2008.
2. Ralph M Barnes **-Motion and Time study**, ISBN:13:978981426182 Publisher: John Wiley, 7th edition 2009.

References Books:

1. M S Sanders and E J McCormic **-Human Factors in Engineering Design**, ISBN: 13:9780070549012, Mc Graw Hill, 7th Edition, 1992.
2. R.S.Bridger **-Introduction to Ergonomics**, ISBN:13:9780849373060, Publisher Taylor and Francis dated 20th Aug 2008, 3rd Edition.

Course outcomes:

Students should be able to:

CO1: Identify areas where there would be a need for improvement of productivity, reduction of ineffective time in an organization. **(PO: a,b,c,e) (PSO1)**

CO2: Analyze and Develop method study techniques and use the correct set of method study techniques, tools for a given scenario **(PO: b, c, e) (PSO2)**

CO3: Provide improvement by usage of the tools, techniques and establish standard time henceforth create an improved model. **(PO: a,c,) (PSO3)**

CO4: Apply the tools and techniques of work study in order to measure the rate of working and establish the incentives for the development both employer and employee **(PO: a,b,e,f) (PSO2)**

CO5: Design and develop the man machine system and its function in industry, society and areas where the effect of such an system can be created. **(PO: a,b,e) (PSO3)**

Manufacturing Technology

Course code: IM34 **Credits: 3 : 0 : 0: 1**

Pre requisite : Nil **Contact hours: 42**

Course Coordinator(s): Dr. R. Shobha / Sudheer D. Kulkarni

Course Objectives:

- To study the ancient and state of the art casting technique to create practical, religious and artistic items to meet customers demand.
- To develop entry level skills in the field of forming methods and fabrication techniques and to apply them to materials community

Course Contents:

Unit I

Introduction: Production, manufacturing and assembly processes, classification of production processes, selection of a process for production.

Casting: Introduction: Steps involved in casting advantages and limitations

Pattern Making: Pattern types, pattern allowances. pattern \ materials, BIS Color coding for patterns.

Unit II

Molding and Molding Methods: Types of molding sand, Ingredients of molding sand, properties. Core sands, ingredients and properties. Green sand molding -hand and machine molding: molding machines-sand slingers, jolt-squeeze machine. No-bake sand molding, ingredients and properties, Shell molding, investment casting, Sodium silicate-Co_2 molding, permanent mold casting, Gravity and Pressure die casting. Centrifugal casting. Continuous casting.

Unit III

Melting Furnaces: Classification, oil fired furnaces, electric furnaces-Arc, resistance and induction furnaces. Cupola-construction, preparation and operation of conventional cupola.

Defects in Castings: Causes and remedies, cleaning and inspection casting-fettling operations, Non-destructive testing, X-ray radiography, dye penetrate test, ultrasonic test, magnetic particle inspection. Advantages and disadvantages

Principles of Gating: Elements of gating system, types of gates, gating ratio, function of risers, types of risers- open, and blind risers.

Unit IV

Introduction to Metal Forming Methods: Introduction, definition, types, hot working and cold working of metals, forging, rolling, extrusion, drawing, and defects.

Soldering, Brazing and Adhesive Bonding : Types, advantages and disadvantages.
Sheet metal forming- Introduction, piercing and blanking operation

Unit V

Advanced Welding Processes: Introduction, Thermit 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. Weldability and weldability testing. Welding defects.

Self study component:

Objectives:

- To study and understand the basic metal joining processes commonly used in industry.

Outcomes:

- Enable students to select and apply the various welding processes considering various parameters.

Evaluation Method:

- The students are evaluated based on their analysis of the given case studies and the answers to the questions given in CIE**.**

Syllabus:

Welding : Classification - Preparation of base metal and joint, fluxes -need and type.

Arc Welding: Principle, Classification, TIG, MIG, SAW, FCAW, Electro slag welding, Atomic hydrogen welding.

Joining Techniques of Plastics, Ceramics and Composites.

Text Books:

1. Heine. Loper **-Principle of Metal Casting**, Phillip, Rosenthal, TMH.2001.
2. P.N. Rao **-Manufacturing Technology: Foundry Forming and Welding**, 2nd edition., TMH, 2003
3. Serope Kalpakjian and Steuen.R.Schniid **- Manufacturing Technology**, Pearson Education Asia, 7th Edition. 2013.
4. E. Paul Degarmo **-Materials and Processes in Manufacturing**, 9th edition, PHI, 2011.

References:

1. Amitabha Ghosh and A K. Mallik **-Manufacturing Science**, East West press,1995.
2. Roy A Lindberg **-Material and Processes of Manufacture**, PHI Publishers, 4th edition, pearson education, 2006.

Course Outcomes:

Students will be able to

CO1: Understand the selection of a particular manufacturing process to be employed for a given application. **(PO:c,h) (PSO1)**

CO2: Understand the basics of casting process and various moulding methods. **(PO:c,e) (PSO1)**

CO3: Select a suitable furnace for a given metal cast to obtain defect free casting. **(PO:a,b) (PSO2)**

CO4: Enhance their knowledge in the area of metal forming techniques. **(PO:c,h) (PSO2)**

CO5: Apply the skills of metal joining technology to meet industrial requirements. **(PO:c,j) (PSO3)**

Mechanics of Materials

Course Code: IM35 **Credits: 3:1:0:0**

Pre requisite: Nil **Contact Hours: 42+ 14 Tutorial Sessions**

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

Course objectives:

- The students will learn about properties of materials and their behavior under different load conditions.
- The students will learn the basic concepts about stress, strain, loads, and its application, designing the suitable cross section of materials under variety of load conditions.

Course Contents:

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 and Shear 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 subjected to pressure change in length, diameter and volume, Lames equations (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 Ananth Ramu **- 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:

The students should be able to

CO1: Judge the effect of stress & strain on various mechanical/machine members of various engineering materials **(PO:a,b,e,h) (PSO1)**

CO2: Analyze the effect of compound stresses on members and effect of torsional moment on rigidity and strength of circular members. **(PO:a,b) (PSO1)**

CO3: Determine the strength and rigidity of various cross sections using SFD and BMD. **(PO:a,b) (PSO1)**

CO4: Design suitable cross sectional dimensions based on bending stress limitations and deflection caused due to stresses and loads. **(PO:a,b,k) (PSO1)**

CO5: 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:a,b,k) (PSO1)**

Basic Thermodynamics

Course Code: IMSC361 **Credits: 3:0:0:0**

Prerequisites: Nil **Contact hours: 42**

Course coordinator(s): M.R. Shivakumar / Sudheer D Kulkarni

Course objectives:

- To learn basic concepts of thermodynamic systems and its parameters.
- To study the work and heat measurement in different thermodynamic system.
- To learn the concept of energy conservation through the study of first law and second law of thermodynamics.
- To understand the deviation of real gas from ideal-gas behavior.

Course Contents:

Unit I

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, 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 (no numerical).

Unit II

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, Pure substance- definition, specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications.

Unit III

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; Equivalence of the two statements; PMM1 and PMM2, Reversible and irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. Thermodynamic temperature scale.

Unit IV

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of a pure substance with water as example. Enthalpy of diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, Separating and throttling calorimeter.

Unit V

Ideal gas: Equation of state, internal energy and enthalpy as functions of temperature only, universal and particular gas constants, specific heats. Evaluation of heat, work, change in internal energy, enthalpy and entropy in various quasi-static processes.

Real gases: Introduction; Vander Waal's Equation ; Van der Waal's constants in terms of critical properties, law of corresponding states, compressibility factor; compressibility chart.

Text Books:

1. P.K. Nag –**Basic and Applied Thermodynamics**, Tata McGraw Hill, 3rd Edition. 2002
2. Yunus A. Cenegal and Michael A. Boles –**Thermodynamics an engineering approach**, Tata McGraw hill Pub. 2006
3. Rajput –**Engineering Thermodynamics**, Laxmi Publication pvt ltd., 3rd Edition. 2007

Reference Books:

1. J.B.Jones and G.A.Hawkin –**Engineering Thermodynamics**, John Wiley and Sons.
2. S.C.Gupta –**Thermodynamics**, Person Edu.Pvt.Ltd., 1st Edition, .2005.

Course outcomes:

The students should be able to

CO1: Apply the concepts of heat and work in thermodynamics devices. **(PO:a,e) (PSO1)**
CO2: Apply the first laws to the thermodynamic system. **(PO:a,e) (PSO1,2)**
CO3: Solve engineering problems by utilizing laws of thermodynamics in devices. **(PO:a,e) (PSO1,2)**
CO4: Analyze the properties of steam at different operating conditions. **(PO:a,e) (PSO1,2)**
CO5: Determine and compare properties of ideal and real gasses. **(PO:a,e) (PSO1,2)**

Fluid Mechanics

Course Code: IMSC362 **Credits: 3:0:0:0**

Prerequisites: Nil **Contact hours: 42**

Course coordinator(s): S. Appaiah / M.R. Shivakumar

Course objectives:

- The basic principles, different properties of fluid and applications of fluid mechanics.
- The basic concepts of fluid static, pressure measurement, buoyancy, kinematics and dynamics of fluid flow.
- The basic concepts of fluid flow measuring equipments such as venturimeter, orifices and Pitot tube.
- The head losses in laminar and turbulent flow through pipes and flow problems.
- Concept of dimensional analysis, similitude and model analysis.

Course Contents:

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, total pressure and location of center of pressure on horizontal/vertical/inclined plane surface and curved surface submerged in a liquid.

UNIT II

Buoyancy : Buoyancy, center of buoyancy, stability of submersed and floating bodies, Meta – center and Meta – centric height, conditions of equilibrium of floating and submerged bodies, Problems.

UNIT III

Fluid Kinematics: Types of fluid flow – introduction, continuity equation in three dimensions (Cartesian co-ordinate system only), velocity and acceleration, velocity potential function and stream function and flow nets.

UNIT IV

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 measurments, 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 V

Laminar flow and viscous effects: Reynolds number, laminar and turbulent flows, critical reynolds number, turbulence intensity, laminar flow through circular pipe – Hagen poiseulle's equation.

Dimensional Analysis: Introduction, derived quantities, dimensions of physical quantities, dinemessinal homogeneity, Rayleigh's method, Buckingham's π theorem dimensionless numbers and their significance, similitude and model studies.

Text Books:

1. Fluid Mechanics by Dr. Bansal. RK Lakshmi publications, 4th edition 2011
2. Fluid Mechanics by stecter, 1st edition 2005
3. Fluid Mechanics and hydrolics, by Jagadishlal, Metropolitan book co-Ltd 4th edition 2004

Reference books:

1. Fluid Mechanics by Modi and Seth, 5th edition 2004
2. Fluid Mechanics by stecter, 1st edition 2005
3. Fluid Mechanics and fluid power Engineering by Kumar .D.S, Kataria & Sons, 2nd edition 2004

Course outcomes:

The students should be able to

CO1: Knowledge of the basic principles and applications of properties of fluid and fluid statics. **(PO: a,b,c,h)(PSO:1)**

CO2: Understanding of the basic concepts of buoyancy and floatation. **(PO: a,b,c,d,h) (PSO:1)**

CO3: Understanding of the basic concepts of fluid kinematics like continuity equation (**PO: a,b,c,d,h**) **(PSO:1)**

CO4: Knowledge of basic concepts of fluid dynamics, friction in pipe flows, fluid flow measurments (**PO: a,b,c,d,h**) **(PSO:1)**

CO5: Understanding of the basic concepts of dimensional analysis Reynolds number for laminar and turbulent flow **(PO:b,c,d,h) (PSO:1)**

Material Testing Lab

Course Code: IML37 **Credits: 0 : 0 :1 : 0**

Pre requisite : Nil **Contact Hours: 14**

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

Course objectives:

- The students will study the behavior of material under varying load conditions by conducting various destructive and non-destructive tests.
- The students will study the microstructure of material by doing surface preparation.
- The students will study the wear characteristics of materials.

Course Contents

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. Izod & charpy impact tests
6. Brinnel's Hardness test of different metallic specimen
7. Rockwell's & Vickers hardness test on metallic specimen
8. Wear test using pin on disc wear testing machine

II Non destructive 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 Ananth Ramu **-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:

The students should be able to

CO1: Suggest appropriate material for practical applications with the knowledge of their mechanical and wear properties. **(PO:a,b,e,h)(PSO:1,2)**

CO2: Identify the various materials and their composition by the study of the microstructure. **(PO:a,b)(PSO:1,2)**

Work study and Ergonomics Lab

Course Code: IML38 **Credits : 0 : 0 : 1 : 0**

Prerequisite: Nil **Contact hours: 14**

Course Coordinator (s): S.Appaiah / V.Vivekanand

Course Objectives:

- Should be able to identify the problem and in accordance apply work study techniques and tools to increase productivity of resources, enterprise and economy as a whole
- To improve their ability to apply the tools and techniques of work study especially method study, work measurement, time study for various scenarios
- To create and improve design of human machine system by reducing stress on human operators and also improve productivity

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. Recording the given activity using Multiple Activity Chart
4. Constructing the String Diagram for a shop-floor activity
5. Construction of Two Handed Process Chart for pin board / Nut and Bolt assembly.
6. Rating practice using walking simulator
7. Rating practice for dealing a deck of cards
8. Rating practice for Marble exercise.
9. Determination of standard time/ rating of pin board assembly using centi minute stop watch.
10. Determination of standard time for simple operation using Timer Pro Software
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. Conduction of work sampling in office environment to determine standard time.
14. Effect of noise, light and heat on human efficiency in work environment.

Text Books:

1. ILO **-Introduction to work study**, ISBN 13:9788120406025 Publisher: India Book House Pvt. Ltd, 4th Revised Edition, 2008.
2. Ralph M Barnes **-Motion and Time study**, ISBN:13:978981426182 Publisher: John Wiley, 7th edition 2009.

References Books:

1. M S Sanders and E J McCormic **-Human Factors in Engineering Design**, ISBN: 13:9780070549012, Mc Graw Hill, 7th Edition, 1992.
2. R.S.Bridger **-Introduction to Ergonomics**, ISBN:13:9780849373060, Publisher Taylor and Francis dated 20th Aug 2008, 3rd Edition.

Course Outcomes:

The student would be able to

CO1: Identify areas where work study tools and techniques can be applied. **(PO:b,i) (PSO1,2).**

CO2: Apply the tools and techniques to various simulated scenarios and real life problems in industry and society. **(PO:c,d,j) (PSO1,2).**

CO3: 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:a,i) (PSO1,2,3).**

M.S. RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE – 54

(Autonomous Institute, Affiliated to VTU)

SCHEME OF TEACHING FOR THE ACADEMIC YEAR 2016-2017 (2015 Batch)

IV SEMESTER B.E. INDUSTRIAL ENGINEERING AND MANAGEMENT

Sl.No.	Subject Code	Subject	Teaching Department	Credits				
				L*	T*	P*	S*	Total
1	IMMAT41	Engg. Mathematics – IV	Mathematics	**3**	**1**	**0**	**0**	**4**
2	IM42	Mechanical Measurements and Metrology	Industrial Engineering & Management	**4**	**0**	**0**	**0**	**4**
3	IM43	Machine Tool Technologies	Industrial Engineering & Management	**3**	**0**	**0**	**1**	**4**
4	IM44	Elements of Machine Design	Industrial Engineering & Management	**3**	**1**	**0**	**0**	**4**
5	IM45	Inventory Management	Industrial Engineering & Management	**4**	**0**	**0**	**0**	**4**
6	IMSC461	Theory of Machines	Industrial Engineering & Management	**3**	**0**	**0**	**0**	**3**
	IMSC462	Mechatronics						
7	IML47	Manufacturing Process and Machine Tools Lab	Industrial Engineering & Management	**0**	**0**	**1**	**0**	**1**
8	IML48	Computer Aided Machine Drawing Lab	Industrial Engineering & Management	**0**	**0**	**1**	**0**	**1**
			Total	**20**	**2**	**2**	**1**	**25**

*** L :** Lecture ***T :** Tutorial ***P :** Practical ***S** : Self Study ***Sc** : Soft Core

* IMSC461- Theory of Machines / IMSC462 – Mechatronics (* Any one of the Two)

Engineering Mathematics – IV

Course Code: IMMAT41 **Credits: 3:1:0:0**

Pre requisite : Nil **Contact Hours: 42+ 14 Tutorial Sessions**

Course Instructor (s): Dr. N.L. Ramesh

Course Objectives:

The students will

- Learn the concepts of finite differences, interpolation and it applications
- Understand the concepts of PDE and its applications to engineering.
- Learn the concepts of consistency, methods of solution for linear system of equations and Eigen value problems.
- Understand the concepts of Graph theory and matrix representation of graphs.

Course Contents:

Unit I

Finite Differences and Interpolation: Forward, Backward differences, Interpolation, Newton-Gregory Forward and Backward Interpolation formulae, Lagrange interpolation formula and Newton divided difference interpolation formula (no proof).

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

Partial Differential Equations - I: Introduction to PDE, Solution of PDE – Direct integration, Method of separation of variables.

Unit II

Partial Differential Equations-II: Classification of second order PDE, Derivation of one dimensional heat and wave equations, Numerical solution of One - dimensional heat and wave equations, Two - dimensional Laplace equation, Poisson equation.

Unit III

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 – Siedal 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 a matrix, system of ODEs as matrix differential equations.

Unit IV

Graph Theory - I: Introduction - Finite and infinite graphs, Incidence and degree, Isolated vertex, Pendant vertex and null graph, Operation 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 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 – 43rd edition – 2015.
3. Narsingh Deo – Graph Theory with applications to engineering & computer Science- Prentice Hall of India – 2004.

References:

1. Glyn James – Advanced Modern Engineering Mathematics – Pearson Education – 4th edition – 2010.
2. Dennis G. Zill, Michael R. Cullen - Advanced Engineering Mathematics, Jones and Barlett Publishers Inc. – 3rd edition – 2009.
3. Reinhard Diestel-Graph Theory-Springer-2nd edition-2006.

Course outcomes:

Students are expected to do the following

CO1: Should be able to use a given data for equal and unequal intervals to find a polynomial function for estimation. Computing maxima, minima, curvature, radius of curvature, arc length, area, surface area and volume using numerical differentiation and integration. **(PO:a,b,e,I,k)(POS:1,2)**

CO2: Solve partial differential equations analytically and numerically. **(PO:a,e,k)(PSO:2,3)**

CO3: Find the rank of a matrix, test the consistency and the solution by Gauss elimination and Gauss Siedel iteration methods . **(PO:a,b,c,k)(PSO:1,2)**

CO4: Should be able to identify different types of graphs and can determine minimal spanning tree of a given graph. **(PO:f,j,k)(PSO:2,3)**

CO5: Matrix representation of graphs. **(PO:f,j,k)(POS:1,3)**

Mechanical Measurements and Metrology

Course Code: IM 42 **Credits: 4 : 0 : 0 : 0**

Prerequisites: Nil **Contact hours: 56**

Course coordinator: R Shobha / M R Shivakumar

Course objectives:

- To learn basic concepts of metrology and measurement system.
- To know principle of linear and angular measurement.
- To learn working principles of various mechanical measuring devices used in industry.
- To get the knowledge about ISO concepts and its application in metrology and measurements.

Course Contents:

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 to the chapter, 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, Use of gear tooth vernier calliper and gear tooth micrometer.

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 and drill tool dynamometer and lathe tool dynamometer.

Measurement of Force, and pressure: Introduction, Analytical balance, Platform balance. Proving ring – sketch and working principle. 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:

The students should be able to

CO1: Apply the concepts of metrology and measurements in industries. **(PO:a,e) (PSO1,2)**

CO2: Design the inspection gauges. **(PO:a,c,e) (PSO1,2)**

CO3: Compare and contrast electromechanical devices used to measure the physical quantities such as pressure, temperature and displacement. **(PO:a,c,e) (PSO1,2)**

CO4: Use the commonly available measuring devices and instruments in varieties of applications. **(PO: e) (PSO1,2)**

CO5: Develop and maintain ISO procedure in metrology and measurements. **(PO: e) (PSO1,2)**

Machine Tool Technology

Course Code: IM43 **Credits: 3:0:0:1**

Pre requisite : Manufacturing Technology **Contact Hours: 42**

Course Coordinator(s): Dr. R. Shobha / M. R. Shivakumar

Course Objectives:

- To understand the concept of theory behind metal cutting and operation of machine tools like lathe milling, drilling, shaping, planning and grinding machines.
- To learn entry level knowledge in the field of nontraditional machining

Course Contents:

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, tool wear & tool failure effects of cutting parameters, Tool life criteria, Taylor's tool life equation, problems on tool life evaluation. Heat generation in metal cutting, factors affecting heat generation, measurement of tool tip temperature.

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. Problems on calculation of machining time.

Shaping: Classifications, constructional features, driving mechanisms, shaping , tool & work holding devices, problems on calculation of machining time.

Unit III

Planing Machine: Classification ,Construction features and operations

Milling Machines: Classification, constructional features, milling cutters & nomenclatures, milling operations, up milling & down milling concepts.

Unit IV

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.

Self study : Selection of Cutting Tool Materials: Desired properties, types of cutting tool materials- HSS carbides, coated carbides, ceramics. Effect of cutting fluids- Properties, types & selection. Definition and factors affecting machinability.

Text Books :

1. Hajra Choudhary, **Workshop Technology** Vol –II, 2010
2. HMT **-Production Technology,** Tata McGraw Hill, 2001
3. Pandey & Shan **-Modem machining process**, TMH,2000.
4. P.N.Rao **-Manufacturing Technology and M/C tool & metal cutting**, Tata Mc Graw Hill, 1998

Reference Books:

1. John .A. Schey **-Introduction to Manufacturing Processes**, McGraw Hill, 3rd Edition, 2001.
2. B J Ranganath **-Metal Cutting and tool design**, Vikas Publications.
3. Amitabha Ghosh & Mallik **-Manufacturing science**, Affiliated East West press, 1995

Students have to submit/present a report on the self studies topic by collecting latest developments through journals/ industries.

Course outcomes:

Students will be able to

CO1: Apply the concept of metal cutting operations and the forces acting during metal cutting and the methods of reducing the heat generation during cutting. **(PO:a,h) (PSO: 1,2)**

CO2: Familiarize the usage, applications and operations of various machine tools like Production lathe, drilling and shaping machines. **(PO:c,e) (PSO: 1,2)**

CO3: Understand the various operations and applications of milling machine. **(PO:c,e) (PSO: 1,2)**

CO4: Apply the indexing methods to solve industrial problems and to understand the importance of grinding machine. **(PO:a,b) (PSO: 1,2)**

CO5: Analyze the concept of modern machining methods and selection of cutting tools and fluids for machinability . **(PO:c,i) (PSO: 1,2)**

Elements of Machine Design

Course Code: IM44 **Credits: 3:1:0:0**

Pre requisite : Strength of Materials **Contact Hours: 42+ 14 Tutorial Sessions**

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

Course objectives:

- Students should learn the concepts of stress analysis, theories of failure
- The student should understand to analyze, design and/or select commonly used machine components.

Course Contents :

Unit I

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. Impact loading. Instantaneous stress due to axial, bending and torsional loading, effect of inertia.

Unit II

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. soderberg's method for combination of stresses.

Unit III

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

Design of shafts: Design for strength and rigidity with study load, types of shafts, properties of shaft material, ASME and BIS codes for design transmission shafts, shaft mountings, forces acting on shaft due to belt drive and gear drive. (Simple numerical problems on static loading).

Unit IV

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: Introduction to Spur & Helical gears. Design of spur gear, Lewi's equation, Lewi's form factor- dynamic and wear load. Design of Helical Gear for strength, dynamic and wear load.

Text Books :

1. Joseph Edward Shigley **-Mechanical Engineering Design**, Tata McGraw Hill, 7th edition, 2008.
2. Robert .L. Norton **-Machine Design**, Pearson Education Asia, 3rd edition, 2009.

Design Data Hand Books :

1. K. Mahadevan and Balaveera Reddy **-Design Data Hand Book**, CBS Publication, 2nd edition, 2005.
2. K. Lingaiah **-Design Data Hand Book**, Suma Publications, 2nd edition 2006, Vol.l & Vol.2.

Reference Books:

1. R S Khurmi and J K Gupta **-A text book of Machine Design**, Eurasia Publishing House, 13th edition, 2005.
2. Holowinko, Laughlin, Hall – **Theory and problems of Machine Design**, -Schaums Outline Series, 2022.
3. N C pandey and C S Shah – **Elements of Mechine Design**, Chorotar Publishing House, 16th edition, 2006.
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:

Students should be able to:

CO1: Suggest suitable material based on various theories of failure under static load and impact load conditions. **(PO:a,b,c,e)(PSO1)**

CO2: Analyze the effect of variable stresses on members subjected to axial/bending or torsional load and combined loading. **(PO:a,b,c,g) (PSO1,2)**

CO3: Suitably design the springs and shafts selecting appropriate material depending on type of load. **(PO:a,b) (PSO1)**

CO4: Design liquid proof riveted/welded joints taking into account the efficiency of the joint. **(PO:a,b,k) (PSO1)**

CO5: Design suitable sized gears as per the standard design procedure and also test for safety of design. **(PO:a,b,i) (PSO1,2)**

Inventory Management

Course Code: IM45 **Credits: 4 : 0 : 0:0**

Prerequisite: Nil **Contact Hours: 56**

Course Coordinator(s): P. R. Dheeraj / V. Vivekanand

Course Objectives:

- To understand the fundamental concepts of materials management.
- To understand basic inventory control systems.

Course Content:

Unit I

Introduction: Operating Environment. Supply Chain Concept. Material Flow. Supply Chain Metrics.
Production Planning System: Manufacturing Planning and Control System. Sales and Operations Planning. Manufacturing Resource Planning. Enterprise Resource Planning. Making the Production Plan.

Unit II

Inventory Fundamentals: Aggregate Inventory Management. Item Inventory Management. Inventory and Flow of Material. Supply and Demand Patterns. Functions of Inventories. Objectives of Inventory Management. Inventory Costs. Financial Statements and Inventory. ABC Inventory Control.

Order Quantities: Economic Order Quantity (EOQ). Variations of EOQ Model. Quantity Discounts. Use of EOQ when Costs are not known. Period Order Quantity (POQ).

Unit III

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 IV

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

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.
2. P Gopalakrishna & M Sundaresan – **Materials Management: An Integrated Approach**, PHI, 2012.

References:

1. A K Dutta – **Materials Management: Procedures, Text and Cases**, PHI, 2009.
2. S D Sharma – **Operations Research**, 4th edition, 2009.
3. Kanti Swaroop – **Operations Research**, S Chand, 2001.

Course Outcomes:

Students will be able to

CO1: Identify the fundamental concepts of materials management. **(PO:a,b,c,e) (PSO1)**
CO2: Develop basic inventory control systems. **(PO:a,b,c,e) (PSO1)**
CO3: Build advanced inventory control systems. **(PO:a,b,c,e) (PSO1,2)**
CO4: Design a basic purchasing system. **(PO:a,b,c,e) (PSO1)**
CO5: Develop a basic warehousing system. **(PO:a,b,c,e) (PSO1,2)**

Theory of Machines

Course Code : IMSC461 **Credits: 3:0:0:0**

Pre requisite : Nil **Contact Hours: 42**

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

Course objectives

- To impart students with the concept of building up of a machine using links, Kinematic Chains and Mechanisms.
- To understand the concept of working of various machine elements like gears, cams and gyroscopes.
- To understand the concept and importance of balancing of rotating masses, thereby reduction of friction wear and tear of mechanical components.

Course contents

Unit I

Introduction, Kinematic chain and Inversions: Definitions, Link or element, pairing of elements with degree of freedom, Grubler's criterion, kinematic chain, mechanisms, mobility of mechanisms, inversion, machine. Kinematic chain with three lower pair, four bar chain, single slider crank chain & double slider crank chain & their inversions.

Kinematic mechanisms: Quick return motion mechanisms –Whitworth mechanisms and Crank & slotted lever mechanism. Straight line mechanisms – Peasellier's mechanisms. Intermittent motion mechanisms – Geneva mechanisms, Toggle mechanism, Pantograph, Hook's joint

Unit II

Spur gear : Law of gearing, Involumetry, Definitions, Characteristics of involute action, path of contact, arc of contact, contact ratio, interference in involute gears, methods of avoiding interference. Simple problems.

Gear trains : Simple gear trains, compound and epicyclic gear trains velocity ratio, tooth load and torque calculations (simple problems with tabular column method only)

Unit III

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 IV

Balancing of Machinery : Balancing of rotating masses, balancing of single revolving mass in two different planes – Masses are on same side and masses are on either side. Balancing of several masses in the same plane – Analytical method. Tabular Column method. Balancing of rotating masses in different planes.

Unit V

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

Text Books:

1. Shigley, Joseph Edminister **-Theory of Machines**, Oxford university press 2011.
2. Sadhu Sing **-Theory of Machines**, Pearson Education, 2008.
3. R. S. Khurmi & J. K. Gupta **-Theory of machines**, Eurasia Publishing House, 2008

References:

1. Thomas Bevan **-Theory of Machines**, Peasson – 2011
2. Ballaney **-Theory of Machines**, Khanna Publication – 2003

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Course outcomes:

Students will be able to

CO1: Determine the mobility of kinematic mechanisms and understand their applications. **(PO:a,c,) (PSO 1)**

CO2: Apply the law of gearing and determine the suitable gear train combination based on the application. **(PO:a,e) (PSO 1)**

CO3: Design a cam profile considering the type of motion of follower. **(PO:a,e) (PSO1)**

CO4: Analyze the rotating masses and determine the balancing forces in a machine. **(PO:a,e) (PSO1,2)**

CO5: Apply the gyroscopic principles and effects on aeroplane, ship and two wheeler. **(PO:a,e) (PSO1,2)**

Mechatronics

Course Code : IMSC462 **Credits: 3 : 0 : 0:0**

Prerequisite: Nil **Contact hour: 42**

Course coordinator(s) : A. Balaksrishna / M. R. Shivakumar

Course Objectives:

- To understand the importance of the integration of modelling and controls in the design of mechatronic systems.
- To understand the importance of physical and mathematical mechatronic system design and be able to model and analyze mechanical, electrical, magnetic, fluid, thermal, and multidisciplinary systems and identify the analogies among the various physical systems.
- To understand the digital implementation of control and basic digital control design techniques in microcontroller and microprocessors
- To have an awareness of more advanced control design techniques, e.g., model predictive control, adaptive control and multivariable control in modern CNC machines and Electrical and Hydraulic actuators

Course contents:

Unit I

Introduction: Definition of mechatronics, Multidisciplinary scenario, scope of mechatronics, an overview of mechatronics. Objectives, advantages and disadvantages of mechatronics. Concept of microprocessor based controller, Principle of working of automatic camera, automotive washing machine.

Unit II

Transducers and Sensors: Definition and classification of transducer, Concept of sensors, classification of sensors, principle of working and application of light sensors, proximity sensors and Hall Effect sensors.

Unit III

Microprocessor: Introduction, microprocessor based digital control, Logic functions, Microprocessor, Microcomputer structure, Registers, Bus, CPU, Memory, Interrupts, Intel 8086A process architecture, Microcontroller, Difference between microprocessor and microcontroller.

Unit IV

Elements of Modern CNC machines: Introduction, Machine structure, Guide ways, Concept of stick-slip phenomenon. Assembly techniques, Guide ways, Ball screw and nut, Spindle Bearings, Misalignment in bearing assembly, preloading of bearings.

Unit V

Actuators: Actuators and actuator system, classification, Electrical actuators, principle construction and working of stepper motor. Hydraulic actuators.

Text Books:

1. Nitaigour & Premcahnd Mahilik **-Mechatronics-principles, concepts and applications**, Tata McGrawHill.2003.
2. W.Bolten **-Mechatronics**, Pearson education Asia, 4th Edition, 2008
3. K.P.Ramachandran, G.K.Vijayaraghavan and M.S.Balasundaram **-Mechtronics-Integrated mechanical Electronic Systems**, Wiley India pvt.. Ltd, 1st edition, 2008

References :

1. David G Alcratore and Michel Billistnd **-Introduction to Mechatronics & measurement systems,** Tata McGrawHill.2000.
2. **Mechatronics** – HMT Ltd, Tata McGrawHill -2000.

Course outcomes:

The students should be able to,

CO1: Apply knowledge of basic science and engineering fundamentals, in depth technical competence in at least one engineering discipline. **(PO:a,e)(PSO:1)**

CO2: Utilize a systems approach to design and operational performance.**(PO:c,k) (PSO:2)**

CO3: Design and implement the digital control techniques in microcontroller and microprocessors. **(PO:a,d,e) (PSO:1)**

CO4: Select and integrate appropriate sensors, actuators and control hardware through an understanding of electro-mechanical systems and processes in CNC machines. **(PO:d,e) (PSO:1,2)**

CO5: Apply the concept of actuators and to design. **(PO:a,e) (PSO:1)**

Manufacturing Processes and Machine Tools Lab

Sub Code : IML47 **Credits = 0: 0: 1: 0**

Pre requisite : Nil **Contact Hours : 14**

Course co-ordinator(s): Dr. R. Shobha / S. Appaiah

Course objectives:

- To develop entry level skills in operation of machine tools like lathe milling and shaping machines.
- To get the hands on experience of the various machine tools.

Course content:

Part A- Manufacturing processes

I Testing of Moulding Sand

1. Shear test
2. Permeability test
3. Grain fineness test
4. Clay content test
5. 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 without patterns (i.e.with hand cutting)

III Forging operations

1. Preparation of square headed bolt
2. Preparation of Hexagonal rod

Part B - Machine Tool Operations

I Lathe with four jaw chuck

1) Thread cutting operation
2) Eccentric operation

II Milling Machine

1) Spur gear cutting

III Shaping Machine

1) Rectangular groove cutting
2) Dovetail cutting

Text Books :

1. Hajra Choudhary, **Workshop Technology** Vol –II, 2010
2. HMT **-Production Technology,** Tata McGraw Hill, 2001
3. P.N.Rao **-Manufacturing Technology and M/C tool & metal cutting**, Tata Mc Graw Hill, 1998

Reference Books:

1. John .A. Schey **-Introduction to Manufacturing Processes**, McGraw Hill, 3rd Edition, 2001.
2. Amitabha Ghosh & Mallik **-Manufacturing science**, Affiliated East West press, 1995

Course outcomes:

The student will be able to

CO1: Apply the concept of manufacturing process and develop the skills in the field of casting technology in certain depth. **(PO:a,,c,d) (PSO: 1,2)**
CO2: Develop the basic concepts of casting and forging**(PO:a,b,d) (PSO: 1,2)**
CO3: Demonstrate the concept behind metal cutting operations**(PO:b,k) (PSO: 1,2)**
CO4: Analyze the working principles of the various machine tools. **(PO: c,h) (PSO: 1,2)**

Computer Aided Machine Drawing Lab

Course Code: IML48 **Credits: 0:0:1:0**

Pre requisite: Computer Aided Engineering Drawing Lab **Contact Hours:14**

Course Coordinator(s): M. Rajesh / M. R. Shivakumar

Course objectives:

To make students

- To prepare engineering drawings meeting BIS standards.
- To familiarize the use of drafting software as an engineering tool.
- To understand the assembly of the machine components.

Course contents:

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
Machine vice

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 Trymbaka murthy **-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:

Students should be able to

CO1: Apply drawing standards and construct 3D machine components. **(PO:a,c,g,h,k) (PSO1,2)**

CO2: Create complex machine drawings. **(PO:c,e,g,j) (PSO1,2)**