RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

DEPARTMENT OF MECHANICAL ENGINEERING

Manufacturing Science & Engineering (MSE)

I – IV Semester M. TECH

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:

History of Department:

The Department of Mechanical Engineering started in the year 1962 with an intake of 40 students. The department has grown strong over the last 52 years and today has an intake of 180 students and 48 teaching staff. All the faculty members are well qualified and possess post graduate degree with 20 doctorates.

The department offers four year degree course and also offers two Master's Degree in Manufacturing Science & Engineering and Computer Integrated Manufacturing, with an intake of 18 each. The Department also offers research program which includes MSc Engineering by research and PhD degree from Visvesvaraya Technological University and at present 24 researchers are pursuing PhD. The department received software grants from Autodesk a leading Computer Aided Design multinational company and has been using them in the curriculum. The faculty members have taken up number of research projects funded by external agencies like DRDO, DST, AICTE and Visvesvaraya Technological University and received funding to the tune of 1 Crore. In view of the golden jubilee celebrations, the department has conducted a national level project exhibition and an International Conference on "Challenges and Opportunities in Mechanical Engineering, Industrial Engineering and Management Studies" – ICCOMIM. Faculty members from the department have published books on different domains of Mechanical Engineering and are recommended by Visvesvaraya Technological University Board of Studies as reference text books.

The students from the department participate both at the national and international competition throughout the year, in the year 2013 – AeRobusta – 4 member student team from the department participated in SAE Aero Design competition and stood 18th position out of 64 teams from all over the world. The team AeRobusta stood FIRST AMONG THE ASIAN COUNTRIES.

Another team from the department also participated in the **year 2018** "Unmanned Air Vehicle System "conducted by U.S. Navy at Maryland, USA. The team secured 5th Place in the technical session out of 36 participating teams from all over the world.
A team of two students also participated in the CAD Design Competition conducted by Autodesk, a CAD multinational company, in association with IIT Madras and secured FIRST PLACE among the teams from all over India with a cash prize of Rs 1,20,000 and also received a free Trip to Autodesk University, held at Las Vegas, USA.

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 M. S. 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

The Vision of the Department

To be a centre of international repute in mechanical engineering and to create qualified human resources needed to meet the demanding challenges in different areas and emerging fields of mechanical engineering and allied sciences.

Mission of the Department

To impart quality technical education to meet the growing needs of the profession through conducive and creative learning environment to produce qualified and skilled human resources in Mechanical Engineering, offer post graduate programme in the emerging fields of Mechanical Engineering, create R & D environment to be a centre of excellence in Mechanical Engineering.

Process of deriving the vision and mission of the department

Process of deriving the vision and mission of the department is shown in block diagram below (fig1)

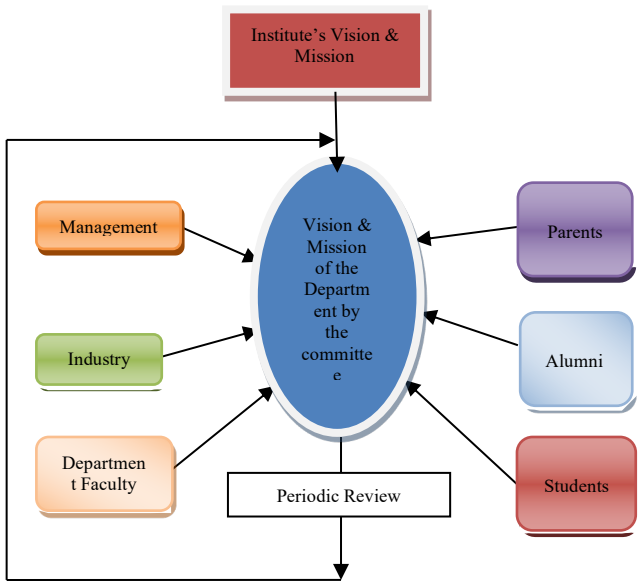

Fig1. Block Diagram – Deriving the Vision & Mission of the department

Programme Educational Objectives (PEOs)

The Mechanical Engineering Program, M.Tech-MSE is a four semester course and will provide the advanced building blocks for conceptualizing, understanding and manufacturing systems integrated with computer based applications. These will include advanced materials, traditional and non-traditional manufacturing methods, advanced manufacturing techniques, advanced foundry technology, computer aided design, product data and management, rapid prototyping, advanced metal joining processes etc. The course includes individual project work carried out by a student to help him understand and demonstrate his learning capability, apply the principles to practical real time situations and would enable him to be technically and professionally equipped and improve for taking up challenging task in the industrial sector, government organization, teaching profession, research organization and pursue higher studies and to become an entrepreneur.

PEOs of the Program

PEO 1: Apply the technical skills gained to model and analyze real time projects in the field of manufacturing science and engineering.

PEO 2: Able to take up profession in R&D areas, management and teaching activity in the field of mechanical engineering.

PEO 3: Engage in industry institute interaction and lifelong learning by adhering to ethical and environmental condition

Process of Deriving the Programme Educational Objectives (PEOs):

Fig 2 shows the process employed for deriving the PEO's

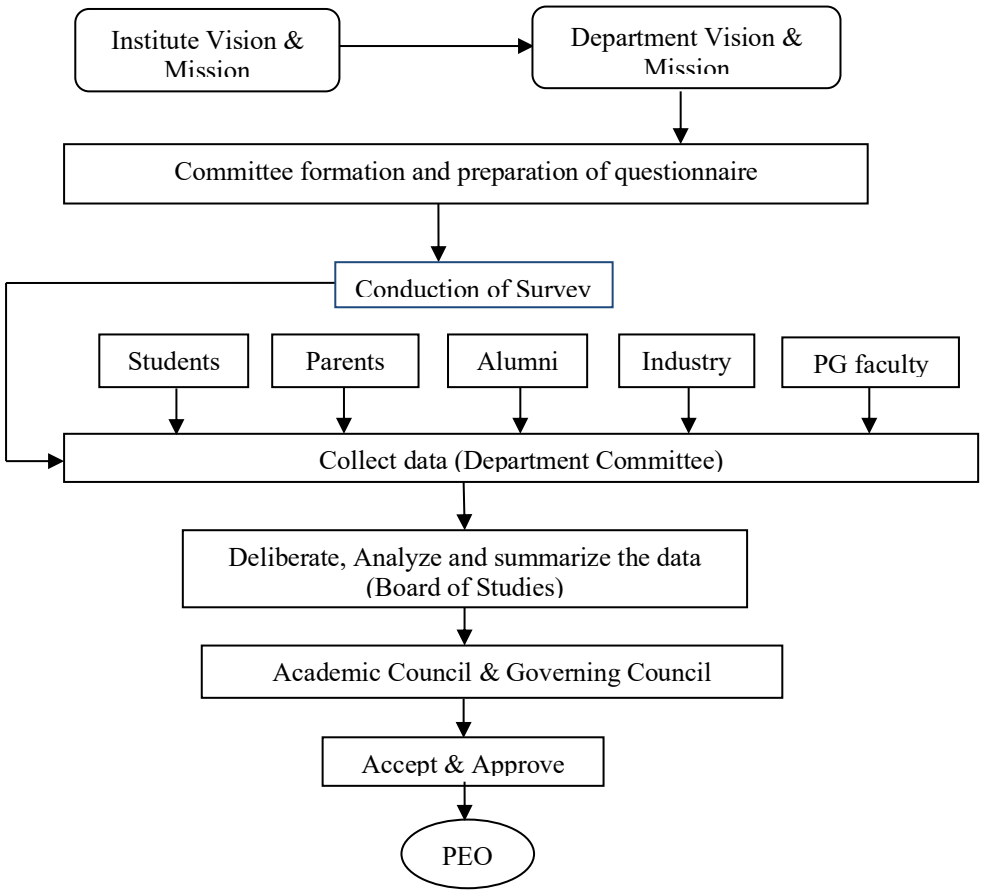

Fig 2 : Process employed for deriving the PEO's of the department

Programme Outcomes (POs):

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial Technical report/document.

PO3: Students should be able to demonstrate a degree of mastering over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Develop an ability to identify problems, explore opportunities, propose feasible solutions, and, nurture a culture of scientific temper, to transform into an accomplished MSE graduate.

PO5: Ability to apply the learned principles to the analysis, development and implementation of manufacturing systems; to prepare oneself to work professionally in academic institutions and industries.

Process of Deriving the Programme Outcomes (POs):

Fig 3 shows the process employed for deriving the PO's

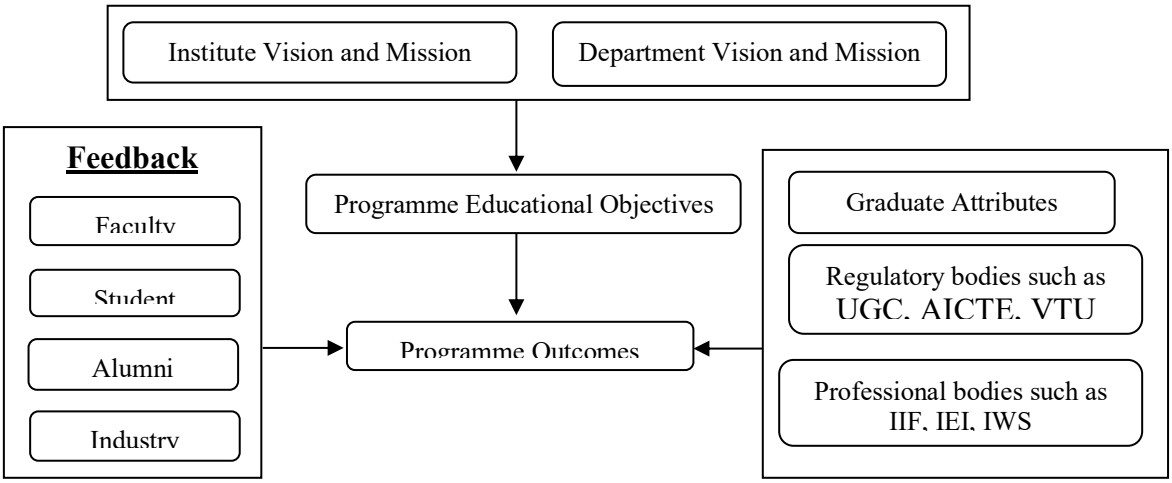

Fig 3: Process employed for deriving PO's

Mapping of PEO's and PO's

The correlation between the Programme outcomes and Program Educational objectives are mapped in the Table1 shown below.

Table 1: Correlation between the POs and the PEOs

Sl. No.	Programme Educational Objectives (PEOs)	Programme Outcomes (POs)				
		PO1	PO2	PO3	PO4	PO5
1	Apply the technical skills gained to model and analyze real time projects in the field of manufacturing science and engineering.	3	3	3	3	3
2	Able to take up profession in R&D areas, management and teaching activity in the field of mechanical engineering.	3	3	3	3	3
3	Engage in industry institute interaction and lifelong learning by adhering to ethical and environmental conditions.	3	3	3	3	3

Master of Technology (M.Tech)
In
Manufacturing Science and Engineering (MSE)

Curriculum - Course Credits Distribution

Semester / Total	Core Courses	Electives	Project Work / Dissertation Preliminaries	Laboratory	Internship /Industrial Training	Seminar	Total
I	08	12	-	02	-	01	**23**
II	08	12	-	02	-	01	**23**
III	04	04	08	-	04	-	**20**
IV	-	-	20	-	-	02	**22**
Total	**20**	**28**	**28**	**04**	**04**	**04**	**88**

FIRST SEMESTER

Sl. No.	Subject Code	Subject	Teaching Dept.	Credits			
				L	T	P	Total
1	MSE11	Experimental methods and Mathematical modelling	Mechanical Engineering	3	1	0	4
2	MSE 12	Machining Science and Technology		3	0	1	4
3	MSEEXX	Elective – I					4
4	MSEEXX	Elective – II					4
5	MSEEXX	Elective – III					4
6	MSE L11	Design of Experiments Laboratory		0	0	1	1
7	MSE L12	Advanced Measurements Laboratory		0	0	1	1
8	MSE 13	Technical Seminar 1		0	0	1	1
Total				**19**	**1**	**3**	**23**

SECOND SEMESTER

Sl. No.	Subject Code	Subject	Teaching Dept.	Credits			
				L	T	P	Total
1	MSE21	Automation and Production systems	Mechanical Engineering	4	0	0	4
2	MSE22	Advanced Foundry Technology		4	0	0	4
3	MSE EXX	Elective – IV					4
4	MSE EXX	Elective – V					4
5	MSE EXX	Elective - VI					4
6	MSEL21	Automation and Simulation Laboratory		0	0	1	1
7	MSEL22	Casting and Simulation Laboratory		0	0	1	1
8	MSE 23	Technical Seminar 2		0	0	1	1
Total				**20**	**0**	**3**	**23**

THIRD SEMESTER

Sl. No.	Subject Code	Subject	Teaching Dept.	Credits			
				L	T	P	Total
1	MSE31	Advanced Metal Forming Processes	Mechanical Engineering	3	0	1	4
2	MSE EXX	Elective - VII					4
3	MSE 32	Internship / Industrial Training		0	0	4	4
4	MSE 33	Project work / Dissertation Preliminaries		0	0	8	8
Total				**8**	**0**	**12**	**20**

FOURTH SEMESTER

Sl. No.	Subject Code	Subject	Teaching Dept.	Credits			
				L	T	P	Total
1	MSE41	Project work / Dissertation	Mechanical Engineering	0	0	20	20
2	MSE42	Project work / Dissertation Seminar		0	0	2	02
Total				**0**	**0**	**22**	**22**

L – Lecture Hours T – Tutorial Hours P – Practical/Seminar

LIST OF ELECTIVES
(Manufacturing Science and Engineering)

Sl. No.	Course Code	Course	Credits			
			L	T	P	Total
1	MSE E01	Advanced Management Techniques in Manufacturing	4	0	0	4
2	MSE E02	Advanced Materials Technology	3	0	1	4
3	MSE E03	Additive Manufacturing	4	0	0	4
4	MSE E04	Simulation and Modelling of Manufacturing Systems	4	0	0	4
5	MSE E05	Flexible Manufacturing Systems	4	0	0	4
6	MSE E06	FEM For Manufacturing	3	0	1	4
7	MSE E07	Mechatronics and MEMS	3	0	1	4
8	MSE E08	Machine Learning and Python	4	0	0	4
9	MSE E09	Condition Based Monitoring	3	0	1	4
10	MSE E10	Tooling for Manufacturing in Automation	3	0	1	4
11	MSE E11	Nanotechnology	4	0	0	4
12	MSE E12	Maintenance Engineering and Management	4	0	0	4
13	MSE E13	Surface Treatment and Finishing Techniques	4	0	0	4
14	MSE E14	Advanced Metal Joining Processes	4	0	0	4
15	MSE E15	Product Data Management	4	0	0	4
16	MSE E16	Industrial Robotics	3	0	1	4
17	MSE E17	CNC systems and Programming	4	0	0	4

EXPERIMENTAL METHODS AND MATHEMATICAL MODELLING

Subject Code: MSE 11 **Credits:3:1:0**
Prerequisites: Nil
Course Coordinator: Dr B P HARICHANDRA

Preamble:
Experimentation is a part of any research work. M. Tech. program requires orientation towards research, and hence requires knowledge of the various experimental and mathematical methods both for project work, for understanding of literature, and for understanding requirements of improvement in the processes/products. This course aims at teaching the students some of the basic aspects of statistical tools like the regression analysis, correlation analysis. The course aims at having understanding of experiments, the various concepts of experiments, teaching how to design and analyze experiments. Various designs of experimentation and their analysis and applications are taught in the subject.

Course Learning Objectives

1. To understand the basic aspects of experimentation, data collection, errors in experimentation and conducting uncertainty analysis.
2. To model the experimental data mathematically through regression; linear, multi and curvilinear.
3. To understand the classification of Design of Experiments and conduct ANOVA for CRD, RBD, LSD designs,
4. To understand and interpret screening experiments, multifactor experiments, fractional factorial experiments; and represent the same graphically
5. To understand the basic aspects of Taguchi (with simple numericals) and know fundamental concepts of RSM.

UNIT I

Experimentation & handling of experimental data:
Fundamentals and principles of experimentation, basic terms and variables in experiments, experimental environment, causes and types of experimental errors – Fixed errors, random errors, error analysis on commonsense basis, Introduction to Uncertainty Analysis in engineering measurements – simple numericals. Handling missing data: Need for statistical approximation of missing data, introduction to various methods. Tutorial exercises from journal papers.

UNIT II

Regression modelling and correlation analysis:
Linear Regression models – Simple Linear Regression, method of least squares, estimation of regression coefficients, analysis of variance of LR, determination of correlation coefficients. multiple regression, curvilinear regression – quadratic, logarithmic and exponential models, Tutorial exercises from journal papers.

UNIT III

Fundamental designs of experiments: Introduction, Classification of Design of Experiments, Basic principles of good design, Completely Randomized Design, Randomized Block Design, Latin Square Design, Analysis of variance in experimental design, Tutorial exercises from journal papers.

UNIT IV

Factorial Design: Factorial design, graphical representation of 2^2 and 2^3 designs, Fractional Factorial Design – blocking and alias sets, Tutorial exercises from journal papers.

UNIT V

Other designs:

Taguchi design – Taguchi's definition of quality, Taguchi's Quality philosophy, Taguchi's Quality loss function, S/N ratios for static cases, for smaller-the-better, larger-the-better, nominal-the-best– simple numericals on S/N ratios and ranking.

Introduction to RSM, Tutorial exercises from journal papers.

REFERENCE BOOKS:

1. Richard A Johnson, "Probability and statistics for engineers", 6th Edition, Pearson education.
2. Phillip J Ross Taguchi "Techniques for quality Engineering 2nd Edition", Mc Graw- Hill 1996.
3. J. P. Holman, "Experimental methods for Engineers", McGraw-Hill International edition
4. Research Methodology, R.Pannerselvam, Prentice Hall of India, New Delhi
5. J.M. Juran, Frank M. Gryna, "Juran's Quality Control Handbook", McGraw-Hill International Edition
6. Douglas C. Montgomery, "Design and Analysis of Experiments" 5th edition, John Wiley and Sons, Inc.

Course Outcomes (COs):

At the end of the course, a student:

1. Would have understood the basic aspects of experimentation, data collection, errors in experimentation and would know how to conduct uncertainty analysis. [PO1,PO2,PO3,PO4 & PO5]
2. Would know to model the experimental data mathematically through regression; linear (along with hypothesis testing), multi and curvilinear. [PO1,PO2,PO3,PO4 & PO5]
3. Would have understand the classification of Design of Experiments and will be able to conduct Mathematical analysis for fundamental designs. [PO1,PO2,PO3,PO4 & PO5]
4. Would have understood two factor, multifactor, fractional factorial experiments; and will be able to represent the same graphically. [PO1,PO2,PO3,PO4 & PO5]
5. Would have understood the basic aspects of Taguchi design approach and do simple problems on Taguchi method and interpret the results; and would have known the fundamental aspects of RSM. [PO1,PO2,PO3,PO4 & PO5]

MACHINING SCIENCE AND TECHNOLOGY

Course Code: MSE 12 **Credits: 3:0:1**
Prerequisites: Fundamentals of Metal Cutting and NTM
Course Coordinator:Dr N D PRASANNA

Preamble

Metal cutting is gaining importance in the present day in almost all manufacturing activities. Decisions regarding this are taken up on fast track basis as well as with the available information to arrive at the optimum time required for any task. This is enabled only by providing the necessary access to the Engineer the right information at the right time and providing in the way it is required. This is being achieved using precision machine tools, computers which provide the data storage, data reduction, value addition for the data, data acquisition, retrieval and data warehousing for effective manufacturing functions. The subject provides the basic fundamental approaches for metal cutting theory. The subject also encompasses the practical aspects with the right information converted to measurable parameter, particularly in manufacturing activities. Traditional machining tools, nomenclature, tool materials, cutting force measurements, tool wear, tool life and thermal aspects related to metal cutting, economics involved during machining, non traditional methods, hybrid machining processes are studied in detail.

Course Learning Objectives:

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

1. Learn the various types of cutting tools, mechanics of metal cutting, tool materials, and the fundamental concepts and derive the relationships for shear plane angle, cutting forces.
2. Apply tool life criterion and effective utilization of the tools, towards decision making processes Illustrate them
3. Learn the fundamentals of different forms of tool wear, tool life equation, thermal aspects during metal cutting, cutting fluids, applications types of cutting fluids, economics, monitoring techniques, performance parameters (with appropriate examples and arrive at the optimum cutting speed and tool life form a maximum production)choose practice and Recommend the same.
4. Understand the importance of non-traditional machining over traditional machining process
5. Clear exposure to Hybrid process for machining operation.

UNIT I

Tools nomenclature, tool point reference systems: Geometry of cutting tools: Single point and multi point cutting tools, tool angle specifications-ISO, ORS and ASA systems, conversion from one system to another. Recommended tool angles, Effect of cutting parameters on tool geometry, Tool Materials and their properties, types of tool materials- high speed steels, cemented carbides, ceramics, diamonds, SIALON, CBN, UCON, recommended cutting speeds for the above tools, tool and die steels-air, water, oil hardening of tools and their applications.

UNIT II

Mechanics of metal cutting: Mechanism of chip formation, orthogonal and oblique cutting, types of chips, built-up edge, Determination of shear plane angle, forces on the chips, forces in orthogonal

cutting, Merchant circle diagram and analysis, Theory of Lee & Shaffer, co-efficient of friction, power & energy relationship, velocity relationship, shear-strain, forces and power, problems.
Measurement of cutting forces: Reasons for measuring cutting forces, Classification of cutting force dynamometers-mechanical, hydraulic, pneumatic, optical, inductance, piezoelectric, strain gage type dynamometers,3 and 5 axis dynamometers, dynamometers for lathe, drilling and milling, calibration of dynamometers.

UNIT III

Tool wear, Tool life: Mechanisms of tool wear, sudden & gradual wear, crater wear, flank wear, tool failure criteria, tool life equations, effect of process parameters on tool life, tool life tests, conventional & accelerated tool wear measurement, machinability index, Thermal Aspects in metal cutting: Heat sources in metal cutting, temperature in chip formation, temperature distribution and experimental determination of tool temperature.
Cutting fluids, Economics of Machining: Introduction, element of total production cost, optimum cutting speed and tool life for minimum cost, optimum cutting speed and tool life for maximum production, problems.

UNIT IV

Non-traditional Machining: Difference between traditional and non-traditional machining.
Ultrasonic Machining: Introduction, the machining system, material removal process, factors affecting material removal rate, dimensional accuracy and surface quality, applications.
Water Jet Machining: The machining system, process parameters, and applications.
Abrasive Jet Machining: The machining system, material removal rate, process parameters, applications.
Abrasive water Jet Machining: The machining system, process capabilities.
Ice Jet Machining: Introduction, process description.
Magnetic Abrasive Finishing: The machining system, material removal, applications.
Chemical Processes: Tooling for CHM, process parameters, material removal rate, accuracy, surface finish, applications.

UNIT V

Thermal Processes:
Mechanics of material removal, MRR, surface integrity, heat affected zone, applications, process control, automation, environmental impact of Electro Discharge Machining, Laser Beam Machining, Electron Beam Machining, Plasma Beam Machining, Ion Beam Machining.

Hybrid Electro-chemical Machining: Mechanics of material removal, MRR, surface integrity, heat affected zone, applications, process control, automation, environmental impact of Electro-chemical grinding, electro chemical honing, Electrochemical superfinishing, electrochemical buffing, ultrasonic-assisted ECM, Laser assisted ECM.

Hybrid Thermal Processes: Electro-erosion dissolution machining, electro-discharge grinding, abrasive electro-discharge machining, EDM with ultrasonic assistance, electrochemical discharge grinding, brush erosion-dissolution mechanical machining.

Lab Component
1. Study of the influence of tool geometry on surface integrity
   - With positive rake angle
   - With negative rake angle

2. Effect of speed, feed, depth of cut and nose radius on surface topography of the components machined using tool inserts
3. Cutting force measurement and construction of Merchant circle diagram as a function of rake angle
4. Study of different types of chips
5. Tool tip temperature measurement during turning of heat treated and cast products
6. Machinability studies on different materials (for different conditions)
    - Machining of the heat treated samples
    - Machining of as-cast product
7. Measurement of tool wear of inserts due to machining

REFERENCE BOOKS:

1. Metal Cutting Principles: M.C Shaw, Oxford Publication. Pub 1978
2. Metal Cutting by Edward.W. Trent. Butterwork Pub, 2006
3. Fundamentals of Metal Machining & machine tools by Boothroyd. McGraw-Hill, 1975
4. Experimental techniques in Metal Cutting by V.C Venkatesh& S. Chandrasekharan Prentice hall. Pub 1987
5. Metal Cutting & tool design by Dr. B.J. Ranganath, Vikas Publication.2007-08
6. Principles of Metal cutting by G. Kuppu Swamy, University press (1996)
7. Advanced Machining processes: Non traditional and hybrid machining processes, Hassan Abdel-Gawad EL-Hofy, McGraw-Hill, mechanical engineering series-2005
8. Bhattacharya "New technology" Institution of Engineers, India
9. HMT "Production technology" Tata Mc Graw Hill.
10. P .C Pandy& H.S. Shan "Modem Machining Process" Tata McGraw Hill.
11. ASM "Metals hand book" Vol-3.
12. F .M Wilson "High velocity forming of metals" ASTME PrenticeHall.
13. Adithan "Modem Manufacturing Method"
14. K . Mishra "Modem Machining Processes".
15. Other related internet sources

Course Outcomes (COs):

At the end of the course, the student will;

1. Identify the various types of cutting tools, mechanics of metal cutting, tool materials. [PO1,PO2,PO3,PO4,& PO5]
2. Explain the concepts and derive the relationships for shear plane angle, cutting forces, tool life criterion, and effective utilization of the tools, towards decision making processes illustrate them. [PO1,PO2,PO3,PO4,& PO5]
3. Classify and analyze the different dynamometers for measuring forces considering Case studies –Draw conclusions. [PO1,PO2,PO3,PO4,& PO5]
4. Differentiate between traditional and non-traditional machining with the capabilities of non-traditional machining over traditional machining [PO1,PO2,PO3,PO4,& PO5]
5. Choose the best hybrid process and take appropriate decision for live problems faced in the industries especially for machining operations. [PO1,PO2,PO3,PO4,& PO5]

DESIGN OF EXPERIMENTS LABORATORY

Course code: MSE L11 **Credits: 0:0:1**
Prerequisites: To have completed/registered for MSE11
Course Coordinator: Dr B P HARICHANDRA

Preamble:

Mathematical modelling and design of experiments is undoubtedly a course that M.Tech students, especially in the field of Mechanical Engineering should undergo. In this context the course MSE11 is introduced. However, today with a number of computer aided facilities are available for the topic, It has become almost inevitable that students use computers for computations. In this context, it is very much essential for the students to know about the use of software in executing the problems on Design of Experiments. This course is aimed at fulfilling the requirement.

Course Learning Objectives:

1. To understand the use of appropriate software(s) for basic statistical analysis and Design of Experiments; and be able to read research papers, understand the results and explain the same.
2. To select an appropriate graphical representation for a given set of data, represent the same using appropriate software(s), mathematically model and analyze the same.
3. To perform Mathematical analysis for different experimental data involving 2 factor design, multifactor design, factorial design and Taguchi design using appropriate software(s)

Learning of appropriate software and implementation of the Parts A and B using the software. The basic data sets shall preferably be taken from journal papers.

Part A: Regression modelling and correlation analysis

Linear Regression, Multiple Regression, Curvilinear Regressions, correlation analysis. Hypothesis testing.

Part B: ANOVA, Optimization.

Analysis and graphical representation and interpretation of 2 factor design, multifactor design, factorial design, Taguchi design. ANCOVA. Optimization techniques & RSM, Artificial Neural Network

Examination

Exam marks: 50 Exam time: 3 Hours.

Component	Marks	Remarks*
Part A	20	Initial write up and preliminary idea of results: 05 marks, Computer work: 05 marks, Presentation of data and results: 05 marks, interpretation of results: 05 marks
Part B	20	Initial write up and preliminary idea of results: 05 marks, Analysis, presentation of data and results: 10 marks interpretation of results: 05 marks
Viva	10	

* The split up may vary depending on the questions.

Reference books:

1. J.M. Juran, Frank M. Gryna, "Juran's Quality Control Handbook" McGrawHill International Editions.
2. Douglas C. Montgomery, "Design and Analysis of Experiments"
3. Hines *et. al.,* "Probability and statistics in engineering", 4th edition, John Wiley and Sons, Inc.
4. Richard A Johnson, "Probability and statistics for engineers", 6th edition, Pearson education.
5. User manuals/Tutorials of the appropriate software used.
6. Lab manual prepared by the department.

Course Outcomes (COs):

At the end of the course, a student will be able to:

1. Understand the use of appropriate software(s) for statistical analysis and Design of Experiments; and be able to read research papers, understand the results and explain the same. [PO1,PO2,PO3 & PO5]
2. Select an appropriate graphical representation for a given set of data, represent the same using appropriate software(s), mathematically model and analyze the same. [PO1,PO2,PO3,PO4 & PO5]
3. Perform hypothesis testing. ANOVA for different experimental data involving 2 factor design, multifactor design, factorial design and Taguchi design using appropriate software(s) [PO1,PO2,PO3 & PO4]

ADVANCED MEASUREMENTS LABORATORY

Course Code : MSE L12 **Credits: 0:0:1**
Prerequisites : Nil
Course Coordinator:Dr JYOTHILAKSHMI R

Course Learning Objectives:

Student will be able to

1. Demonstrate the concepts learnt in Mechanical Measurements and Metrology through experiments
2. Choose Proper measuring Instruments for measurement purpose
3. Understand and explain the concept of Calibration

Part-A

Calibration of Measuring Devices(CMM, Dial Gauge), Measurements of Model Dimensions using CMM(MCS, PCS), Thermal Property assessment for metals and alloys(Thermal Conductivity, Thermal Expansion)

Part-B

Surface Roughness Measurements . Analysis of cutting forces, Toll tip Temperature Measurements

Reference: Department Manual

Examination

Exam marks: 50 Exam time: 3 Hours

Component	Marks	Remarks
Part A	25	Group experiment
Part B	15	Individual experiment
Viva	10	
Total	50	

Course Outcomes (COs):

Student Will be able to

1. Perform measurements precisely, analyze and interpret the results [PO1,PO2 & PO3]
2. Demonstrate the Calibration Procedure of Measuring Instruments[PO1,PO2 & PO3]
3. Solve Measurement related problems encountered in Industries[PO1,PO2 & PO3]

TECHNICAL SEMINAR 1

Course Code : MSE 13 **Credits: 0:0:1**
Prerequisites : Nil
Course Coordinator: Dr B P HARICHANDRA

Preamble:

M. Tech. being post graduate program, the students should know the latest information in their fields. One of the ways to keep them updated is by the study of journal papers in the field. Explanation of the papers in the field will further enhance their communication skills. Teaching being one of the important careers an M. Tech student can take up, understanding and explaining these journal papers will be an added advantage. Apart from these, writing a journal paper is desirable of the program. Hence by studying the journal papers and trying to present their understanding as part of the seminar help students identify good journals, can know what journal expect from a paper, can understand the shortcomings and plus points of published papers. This will also help the students write review papers.

Course Learning Objectives:

This course helps the students

1. To indentify good journals and journal papers; study the papers and understand, analyze, interpret and explain the contents of the paper
2. To develop overall skills for technical communication and help technical decision making
3. To understand the latest research in their field of study.

Scheme of seminars:

Students shall select published journal papers, related to their specialization, read, understand, prepare slides and present the same. Each student shall present their understanding of at least three Journal papers. All students shall attend the seminars of other students of their specialization. A copy of the full paper shall be got signed by the evaluating faculties and the same shall be maintained by the student and submitted at the end for marks finalization. The students shall select the journal paper themselves with the assistance of faculties, if required. Papers shall be selected only from peer reviewed unpaid journals.

Evaluation:

Each presentation shall be evaluated for 50 marks. Average marks obtained for three best presentations will be the student's CIE marks. No SEE.

Course Outcomes (COs):

The student will be able

1. To indentify good journals and journal papers; study the papers and understand, analyze, interpret and explain the contents of the paper[PO1,PO2,PO3,PO4,& PO5]
2. To develop overall skills for technical communication and help technical decision making [PO1,PO2,PO3,PO4,& PO5]
3. To understand the latest research in their field of study. [PO1,PO2,PO3,PO4,& PO5]

AUTOMATION AND PRODUCTION SYSTEMS

Course Code: MSE 21 **Credits: 4:0:0**
Prerequisites : Nil
Course Coordinator: Dr. VISHWANATH KOTI

Preamble:
Automation technology such as robotics, machine tools, handling systems, controllers and computers are the basis of almost all important industries in the world and provide manufacturing industry with the means to improve quality, reduce errors, increase productivity and reduce cycle times. Manufacturing has had a long history, ranging from the initial creation of simple, hand-crafted items, to the development of large complex factories that include a host of factory-related production and fabrication techniques. The study of the systems of manufacturing and production has evolved into a complex field of research in its own right. Manufacturing and production in the contemporary world faces many challenges. This Course is designed to emphasize the knowledge on the automation, sensors, PLCs and advanced manufacturing techniques and impart the student with knowledge of concepts and techniques, which have recently been applied in many practical situations. It gives a framework of knowledge that allows the students to develop an interdisciplinary understanding and integrated approach to overcome the challenges of automation and production systems.

Course Learning Objective:

1. The aim of the course is to make the student to understand the concept of Automation in production system, levels and strategies of automation, concepts of production and mathematical models
2. To enable the student in understanding the basic elements of automation, sensors, actuators and other control system components for discrete data handling
3. To enable a student to develop ladder logic diagrams and PLC programming for industrial automation applications and understand the concept of material handling and transportation system.
4. To enable the student to understand the concept of Storage System and its location Strategies, Conventional and Automated storage systems and Analysis of Storage System.
5. To enable the student to learn and understand FMS and Automated System Assembly

UNIT I

Introduction: Production System Facilities, Manufacturing Support Systems, Automation in Production Systems, Manual Labor in Production Systems, Automation Principles and Strategies, Ten Strategies for Automation and Production Systems, Basic Elements of Automated System, Advanced Automation Functions, Levels of Automation. Production concepts and mathematical models

UNIT II

Basic Elements of an Automated System: Process Industries Versus Discrete Manufacturing Industries, Continuous Versus Discrete Control, Computer process control Forms of Computer Process Control.
Sensors, Actuators, and Other Control System Components: Sensors, Actuators, Analog-to-Digital Conversion, Digital-to-Analog Conversion, Input / Output Devices for Discrete Data.

UNIT III

Discrete Control Using Programmable Logic Controllers and Personal Computers: Discrete Process Control, Ladder Logic Diagrams, Programmable Logic Controller, Personal Computers Using Soft Logic.

Material Handling and Transportation System: Overview Material Handling Equipment, Considerations in Material Handling System Design, Principles of Material Handling, Industrial Trucks, Automated Guided Vehicle Systems, Monorails and Other Rail Guided Vehicles, IDA Conveyors Systems, Crane and Hoists, Analysis of Material Transport Systems.

UNIT IV

Storage Systems: Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated storage systems, Engineering Analysis of Storage System.

UNIT V

FMS and Automated System Assembly: What is FMS, FMS Components, FMS Applications and Benefits, FMS Planning and Implementation Issues, Quantitative Analysis of Flexible Manufacturing Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, Quantitative Analysis of Assembly Systems.

REFERENCE BOOKS

1. David J Parrish ―Flexible manufacturing, Butterworth-Heinemann Publisher, 1990 ISBN: 9780750610117
2. Mikell P Groover ―Automation, Production Systems and Computer Integrated Manufacturing‖, Prentice Hall India (P) Ltd, 2008 ISBN: 9780132393218
3. William W. Luggen ―Flexible Manufacturing Cells & Systems‖ Prentice hall, 2006, ISBN: 9780133217384
4. H.K. Shivanand, M.M. Benal, V. Koti - New Age International Publisher (2006), **ISBN-:** 978-8122418705

Course Outcomes (COs):

1. Identification, Classification of different Automation types in Production System and application of production concepts using mathematical models. [PO1, PO2, PO3, PO4 & PO5]
2. Analyze the concepts of Automation with respect to Process Industries and Discrete Manufacturing Industries. [PO1, PO2, PO3, PO4 & PO5]
3. Apply the concepts of mathematical models in material handling, Automation System and discrete control using PLCs. [PO1, PO2, PO3, PO4 & PO5]
4. Apply the concepts of mathematical models in automated storage systems. [PO1, PO2, PO3, PO4 & PO5]
5. Evaluate the techniques involved in FMS. [PO1, PO2, PO3, PO4 & PO5]

ADVANCED FOUNDRY TECHNOLOGY

Course Code: MSE22 **Credits: 4:0:0**
Prerequisites: Fundamentals of Foundry Technology
Course Coordinator: Dr N D PRASANNA

Preamble

The subject comprises a wider and deeper on the engineering aspects of the materials and methods involved in making castings. It covers bigger spectrum for manufacture products by the casting techniques with require attributes specify for certain purpose such as intricacy, features detail, soundness and others. The topics are based upon the recent developments in this field and include Foundry Metallurgy, Solidification, Casting design, Riser Design, Gating Design, Furnace Technology, Metal melting & treatment, Cast Iron, Aluminum and Magnesium foundry practices, Foundry Mechanization and Modernization, casting quality & evaluation. It is aimed to improve the professionalism and status of casting technology, and with it the products, whilst the subject has been seen in an industrial context, it has been considered equally essential to include ideas arising from basic research in the field of casting. It is hoped that such a treatment will help to strengthen the links between the industry and the centers of education and research.

Course Learning Objective

At the end of this course, the student would be able to understand:

1. Basics of Foundry metallurgy, concept of solidification of metals., Interpretation and use of cooling curves
2. Design aspects of related to casting, riser and gating system
3. Advanced melting techniques and control of casting quality
4. Cast iron foundry, particular attention to grey cast iron, ductile iron and malleable iron
5. Aluminum alloy, copper alloy foundry practice discussing principal alloys such as Al-Si, Al-Cu and Al-Zn-Mg, Mechanization and Modernization of foundry, Robotic applications.

UNIT I

Foundry Metallurgy: Oxidation of liquid metals, gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, Shrinkage of liquid metals.
Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation. Growth mechanism. Solidification of pure metals and alloys. Mechanism of columnar and dendritic growth. Coring or Segregation. Solidification time and Chvorinov's rule. Concept of progressive and directional solidification. Interpretation and Use of Cooling Curves (Thermal Analysis), X-Ray Imaging of Solidification Processes and Microstructure Evaluation.

UNIT II

Casting Design: Initial considerations in design, Functional design, Simplification of foundry practices, Metallurgical design, Economic considerations.
Riser Design: Types of risers and their application, Optimum riser design, Feed metal volume, Riser location, Progressive and directional Solidification, Feeding Distance, NRL method, Feeding aids used in riser design, Factors in riser size, computerized method of riser design.
Gating Design: Components of Gating system, Effects of gates on aspiration, turbulence and dross trap, Presurised versus unpressurized systems, Vertical versus horizontal gating systems.

UNIT III

Furnace Technology: Cupola and its recent developments, charge calculation, Electron Beam Melting, Plasma Melting and Heating, Electroslag Remelting.

Casting Quality Control: Casting defects: Shaping faults arising in pouring, Inclusions and sand defects, Gas defects, Shrinkage defects, Contraction defects, Dimensional errors, Compositional errors and segregation. Different inspection and testing methods to evaluate the casting. Coating of Castings, Quality control activities in a foundry.

UNIT IV

Cast Iron Metallurgy: Classification of cast iron, Composition and graphitization, Carbon equivalent, Graphite morphology, effect of various elements.

Grey cast iron foundry practice: Melting practice, Inoculation, grey iron alloying, pouring, Gating and feeding systems, Foundry properties and engineering properties, Specification, Heat treatment, Applications.

Ductile iron foundry practice: Melting practice, Desulfurization methods, Composition control, magnesium treatment, inoculation, casting and solidification, Engineering Properties, Austempered Ductile iron (ADI),Applications.

Malleable iron foundry practice: Melting practice, Structure of White-heart and black-heart malleable cast iron, Pearlitic malleable iron, Properties and applications.

UNIT V

Aluminium alloy foundry practice: Melting practice, Moulding, Gating and Risering system, Effects of alloying and impurity elements, grain refinement effects, modification and refinement of Al-Si, Al-Cu and Al-Zn-Mg alloys, heat treatment, Properties and applications.

Magnesium alloy foundry practice: Melting practice, Moulding, Alloying additions, Properties and Applications.

Foundry Mechanization and Modernization: Introduction to modernization. Mechanization of foundry and its advantages. Mechanization of sand plant, moulding and core making mechanization in melting, pouring and shakeout units. Material handling equipments and conveyor systems. Brief sketches and description of layouts of job. Captive and mechanized foundries. Foundry robotic applications.

REFERENCE BOOKS:

1. R W Heine, C R Loper, and P C Rosenthal, Principles of Metal Casting, 2nd ed, Tata McGraw Hill, 1976.
2. Beelely, P.R. Foundry Technology, Butterworth, 2001 edition.
3. ASM Handbook, Casting, Vol. 15, ASM Publication, Materials Park, Ohio, 2008.
4. Lal, M. Khanna, O.P., A test book of Foundry Technology Dhapat Rai & Sons Publication, 2007.

Course Outcomes (COs):

At the end of this course, the student demonstrate the ability to

1. Deepened knowledge of science and engineering of solidification of alloys, interpretation of cooling curves, imaging of solidification process and microstructure. [PO1,PO2,PO3,PO4,& PO5]
2. Design casting, gating and risering systems. [PO1,PO2,PO3,PO4,& PO5]
3. Select melting and molding techniques for a particular alloy. [PO1,PO2,PO3,PO4,& PO5]

4. Exercise control over c a s t i n g quality, knowledge in inspection, testing methods - quality control activities. [PO1,PO2,PO3,PO4,& PO5]
5. Apply the techniques, skills and engineering tools to produce castings (ferrous and nonferrous Metals), Modern technology employed in the foundry process, mechanization. [PO1,PO2,PO3,PO4,& PO5]

AUTOMATION AND SIMULATION LABORATORY

Course Code : MSE L21 **Credits: 0:0:1**
Prerequisites : Nil
Course Coordinator: Mr. NANDEESH H L

Preamble

Simulation is the method of imitating the actual process in a virtual environment. This involves generating mathematical models to simulate the manufacturing systems. Simulation helps to reduce the experimentation cost and time and provides the user with the approximate results in optimum time. Simulation can solve a wide range of problems ranging from simple queuing to complicated problems. Ability to create Simulation Software adds on to a student's overall skill and may help him explore such job opportunities. The laboratory course aims at imparting necessary skills in a student to develop Simulation Software with a wide area of application.

Course Learning Objectives:

1. To emulate an ability to identify various opportunities for automation on a production floor.
2. To inculcate skills to practically simulate various processes of production for optimization.

Part A: Queuing Simulation – Simulating common and unique scenarios in a production environment through Single & Multiple Channel Queuing Techniques on a spreadsheet platform.

Part B: Inventory & Reliability Simulation – Simulating exercises on Inventory, Assembly-Lines, Material-Handling Systems on a spreadsheet platform.

Examination
Exam Marks: 50 Exam Time: 3 Hours

Component	Marks	Remarks
Part-A	20	Simulation Table – 10 Marks + Execution – 10 Marks
Part-B	20	Simulation Table – 10 Marks + Execution – 10 Marks
Viva	10	

Course Outcomes (COs):

Students will be able to

1. Understand the vast potential of using a software for simulating production environment scenarios. [PO1,PO2,PO3,PO4 & PO5]
2. Apply the knowledge of simulation to convert manual techniques into executable algorithms. [PO1,PO2,PO3,PO4 & PO5]
3. Create Simulation Software using spreadsheets to simulate various processes such as queuing, inventory, assembly lines and material-handling for enhanced productivity. [PO1,PO2,PO3,PO4 & PO5]

FOUNDRY AND CASTING SIMULATION LABORATORY

Course code: MSE L22 **Credits: 0:0:1**

Prerequisites: Nil
Course Coordinator: Dr. C SIDDARAJU

Preamble:
Casting is one of the oldest manufacturing processes and even today is the first step in manufacturing most products.. In this context it is very much essential for the students to know the casting of aluminum, copper and to know about their microstructure and to identify defects. .

Course Learning Objectives:

1. To understand the aspects of casting methods to produce castings using green sand and no bake sand.
2. To identify and quantify the defects in castings
3. To conduct simulation studies of castings

Part A: Foundry work

- Testing of moulding and core sand
- Mould making using green sand mould, no bake sands.
- Casting of aluminium
- Microstructure studies of cast components
- Identification of defects (internal and external) (Porosity checking, inclusion pin, holes and hot shortness etc.) and quantification of the same using optical microscope.

Part B: Simulation of castings

- Simulation and analysis of sand casting processes, investment casting and centrifugal casting
- Solving solidification related issues with examples / case studies
- Moulds & Cores: mould dimension, parting planes, optimizing cavities, metal mould ratio, core/mould materials, hollow extraction
- Gating design and molding filling simulation
- Feeder design and Solidification analysis: mass distribution, prediction of hot-spots, concept of thermal modulus, skin & mushy solidification, micro & macro shrinkage, temperature distributions, hot tears
- Flow analysis: liquid fractions, cold shuts, mis-runs, turbulence, top filling, inclusions

REFERENCE BOOKS:

1. R W Heine, C R Loper, and P C Rosenthal, Principles of Metal Casting, 2nd ed, Tata McGraw Hill, 1976.
2. Beelely, P.R. Foundry Technology, Butterworth, 2001 edition.
3. ASM Handbook, Casting, Vol. 15, ASM Publication, Materials Park, Ohio, 2008.
4. Lal, M. Khanna, O.P., A test book of Foundry Technology DhapatRai& Sons Publication, 2007.

Examination

Exam marks: 50 Exam time: 3 Hours

Component	Marks
Part A	25
Part B	15
Viva	10
Total	50

Course Outcomes (COs):

At the end of the course, a student will be able to:

1. Produce fairly complicated castings using green sand and no bake sand. [PO1,PO3,PO4,& PO5]
2. Identification and quantification of defects in castings. [PO1,PO2,PO3,PO4,& PO5]
3. Simulate solidification of castings. [PO1,PO2,PO3,PO4,& PO5]

TECHNICAL SEMINAR 2

Course Code : MSE 23 **Credits: 0:0:1**
Prerequisites : Nil
Coordinator : Dr. B P HARICHANDRA

Preamble:

M.Tech. being post graduate program, the students should know the latest information in their fields. One of the ways to keep them updated is by the study of journal papers in the field. Explanation of the papers in the field will further enhance their communication skills. Teaching being one of the important careers an M.Tech student can take up, understanding and explaining these journal papers will be an added advantage. Apart from these writing a journal paper is desirable of the program. Hence by studying the journal papers and trying to present their understanding as part of the seminar help students identify good journals, can know what journal expect from a paper, can understand the shortcomings and plus points of published papers. This will also help the students write review papers and choose topics for their research

Course Learning Objectives:

This course helps the students

1. To indentify good journals and journal papers; study the papers and understand, analyze, interpret and explain the contents of the paper
2. To develop overall skills for technical communication and help technical decision making
3. To understand the latest research in their field of study and try to formulate a research problem.

Scheme of seminars:

Students shall select published journal papers, related to their specialization, read, understand, prepare slides and present the same. Each student shall present their understanding of at least three Journal papers. All students shall attend the seminars of other students of their specialization. A copy of the full paper shall be got signed by the evaluating faculties and the same shall be maintained by the student and submitted at the end for marks finalization. The students shall select the journal paper themselves with the assistance of faculties, if required. Papers shall be selected only from peer reviewed unpaid journals.

Evaluation:

Each presentation shall be evaluated for 50 marks. Average marks obtained for three best presentations will be the student's CIE marks. No SEE.

Course Outcomes (COs):

The student will be able

1. To indentify good journals and journal papers; study the papers and understand, analyze, interpret and explain the contents of the paper[PO1,PO2,PO3,PO4, & PO5]
2. To develop overall skills for technical communication and help technical decision making [PO1,PO2,PO3,PO4,& PO5]
3. To understand the latest research in their field of study and try to formulate a research problem. [PO1,PO2,PO3,PO4,& PO5]

ADVANCED METAL FORMING PROCESSES

Course Code: MSE31 **Credits: 3:0:1**
Prerequisites: Manufacturing Process
Course Coordinator:Dr NAGESH S N

Preamble:

The basic objective of forming process is to produce the components having superior properties compared with the other manufacturing process. The components obtained from this process can be used for the critical applications. The present course deals with various process such as forging, rolling, drawing, extrusion and sheet metal forming process. The various parameters, load calculations and the defects occurred during the manufacture of wrought products will be studied

Course Learning Objectives

1. To apply the knowledge in the field of metal working process and to differentiate with other manufacturing techniques.
2. To assess different methods of forming process for different materials
3. To analyze the basic concepts of stress, yield criteria required for the deformation analysis and parameters affecting the Metal forming process.
4. To analyze load calculations required for the different forming process and assess the variables responsible for the defects in different forming process.
5. To apply the techniques for the selection proper forming methods for preparation of various wrought components

UNIT I

Introduction to forming process: Introduction to forming process, classification, properties of wrought products. Concept of stresses: true stress, true strain and their relationships, Determination of principal stresses, stress, determination flow stress, Yield criteria, plane stress and plane strain, deformation analysis, Numerical problems.
Effect of temperature, metallurgical structure, speed of deformation, Deformation Zone geometry, Friction and Residual stresses in metal forming process.

UNIT II

Forging: Classification, various stages during forging process, Forging equipment, determination of forging load using slab analysis, friction hill, design of forging die, forging defects, residual stresses in forging , Numerical problems.

UNIT III

Rolling: Classification, Rolling mills, rolling of bars and shapes, Theories of hot and cold rolling Determination of rolling load using slab analysis, forces and geometrical relationships, Effect of front and back tension in rolling process, Determination of roll separating force, torque , power and power losses in bearing , Numerical problems, defects in rolled products, residual stresses in rolled products.

UNIT IV

Drawing: Introduction, principles of rod and wire drawing, analysis of wire/rod drawing, tube drawing, analysis of tube drawing, Numerical problems, residual stresses in rod, wire and tubes, Defects in wire, rod and tubes.

Extrusion: Classification, Extrusion equipment, analysis of extrusion process, Numerical problems, Deformation in Extrusion, Lubrication and Extrusion defects, Production of Seamless pipe and tubing

UNIT V

Sheet metal forming: Introduction, forming methods, operations, deep drawing, Forces in circular cup drawing, Drawability of sheet metal, forming limit diagram, Deep drawing with tractrix dies, Numerical problems, High energy rate forming processes.

Laboratory component

Analysis of open die forging, closed die forging, metal extrusion process , Bulk sheet metal forming

REFERENCE BOOKS:

1. Mechanical Metallurgy-Dieter G.E.-Mc Graw publications
2. Principles of metal working- R.Rowe-Amold London
3. Metals Hand book – volumeII-ASM
4. Fundamentals of forming processes-B.L Juneja, New age International Publishers
5. Fundamentals of working of metals- sach G. Pergamon press

Course Outcomes (COs):

Students should be able to

1. Describe the metal forming process and different types of metal forming process. [PO1,PO2,PO3,PO4,& PO5]
2. Explain the various factors/variables affecting the metal forming process and identify the various defects encountered during the process. [PO1,PO2,PO3,PO4,& PO5]
3. Select the suitable materials, equipments and various forming operations carried out to get various wrought products. [PO1,PO2,PO3,PO4,& PO5]
4. Analyze the various stresses, methods of yield criteria for the deformation analysis of various forming process. [PO1,PO2,PO3,PO4,& PO5]
5. Compute the load acting on the components for different metal forming process. [PO1,PO2,PO3,PO4,& PO5]

INTERNSHIP/INDUSTRIAL TRAINING

Course Code : MSE 32 **Credits: 0:0:4**
Prerequisites : Nil
Coordinator : Dr. B P HARICHANDRA

Preamble:

Preamble: Any manufacturing engineering candidate would ultimately require ability for research or be able to solve problems in industries. Hence a candidate would be required to have a practical exposure to some typical industries. In this connection Industrial Training / Internship goes a long way in helping the candidates give an actual exposure to industrial environment. Hence this course is being introduced.

Course Learning Objectives:

At the end of the internship / industrial training duration, a candidate

1. Would have required exposure to industry / research center.
2. Would have handled live problems in industry / research centers
3. Would have developed basic managerial skill in taking up technical research / industry related problems.

Course Outcomes (COs):

At the end of the internship / industrial training duration, a candidate would have

1. Acquired exposure to industry / research center. [PO1,PO2,PO3,PO4,& PO5]
2. Handled live problems in industry / research centers[PO1,PO2,PO3,PO4, & PO5]
3. Developed basic managerial skill for taking up technical research / industry related problems. [PO1,PO2,PO3,PO4,& PO5]

PROJECT WORK / DISSERTATION PRELIMINARIES

Course Code : MSE 33 **Credits: 0:0:8**
Prerequisites : Nil
Coordinator : Dr PRAKRATHI .S

Preamble:

The students are required to take up a project work relevant to the course, which involves literature review, problem formulation, experimentation, analysis of results and discussion. In this background the preliminary work involving literature review and problem formulation will be taken up during the III Semester. The department will provide one supervisor for each candidate, under whose supervision the entire project will be executed.

Course Learning Objective:

1. To conduct literature review, understand well, with an aim of identifying a problem in the area relevant to the program.
2. To formulate a research problem in the area relevant to the program
3. To prepare a consolidated report of the literature survey and the problem formulation

Course Outcome (COs):

1. The candidate will be able to identify a problem in the area relevant to the program through literature survey. [PO1,PO2,PO3,PO4,& PO5]
2. The candidate would have formulated a research problem in the area relevant to the program. [PO1,PO2,PO3,PO4,& PO5]
3. The candidate would have prepared an consolidated report of the literature survey and problem formulation. [PO2,PO4,& PO5]

PROJECT WORK / DISSERTATION

Course Code : MSE 41 **Credits: 0:0:20**
Prerequisites : Nil
Coordinator : Dr PRAKRATHI .S

Preamble:

During the III Semester, through literature survey and discussion with the supervisor allotted by the department, the candidate would have formulated a research problem. During the Phase II, based on the problem formulation, experimentation will be carried out, followed by results and discussion. As a last part of the project work, in Phase III, the candidate shall prepare a project report in bound form and submit the same to the department, with due certification by the supervisor.

Course Learning Objective:

1. The candidate should be able to apply the technical knowledge learnt to prepare a methodology to solve the problem formulated
2. The candidate should be able to conduct the experiments according the standards acceptable by the peers, understand, analyze and evaluate the results obtained.
3. The candidate should be able to prepare a comprehensive report of the project work,
4. To write a technical paper for a peer reviewed journal.

Course Outcomes (COs):

1. The candidate would have applied the technical knowledge learnt to prepare a methodology to solve the research problem formulated. [PO1,PO2,PO3,PO4,& PO5]
2. The candidate would have conducted the experiments according the standards acceptable by the peers, and will be able to demonstrate and analyze results obtained. [PO1,PO2,PO3,PO4, & PO5]
3. The candidate would have prepared a comprehensive report of the project work. (a technical article in peer reviewed journals) [PO1,PO2,PO3,PO4,& PO5]

PROJECT WORK / DISSERTATION SEMINAR

Course Code : MSE 42 **Credits: 0:0:2**
Prerequisites : Nil
Coordinator : Dr PRAKRATHI .S

Preamble:

The candidate should be able to effectively, orally present a seminar on the project work executed during the III and IV semesters. The same shall be evaluated by a panel of examiners recommended by the department.

Course Learning Objective:

1. To prepare a suitable computer aided slides on the project work carried out
2. To present orally the details of the project work carried out.
3. To prove the ability to defend questions arising out of the project work with respect to correctness and acceptability

Course Outcomes (COs):

1. The candidate will have prepared suitable computer aided presentation on the project work carried out. [PO2,PO3,PO4,& PO5]
2. The candidate will be able to present orally the details of the project work carried out. [PO2,PO3,PO4,& PO5]
3. The candidate will be able to prove the ability to defend questions arising out of the project work with respect to correctness and acceptability [PO1,PO2,PO3,PO4,& PO5]

ELECTIVE COURSES

ADVANCED MANAGEMENT TECHNIQUES IN MANUFACTURING

Course Code: MSE E01 **Credits: 4:0:0**
Prerequisites: Nil
Course Coordinator: Dr. VISHWANATH KOTI

Preamble

Advanced Topics in Manufacturing is a new domain featuring tools and techniques that help manufacturers gain productivity and enable constant monitoring mechanisms helping industry focus on reduced lead time and enhanced work rejection rates. Areas such as just in time production is discussed with use of software packages making production system move to the next level. Quality control and its methods enable companies to ensure quality products reach market and various techniques available to enhance the checking process thereby enabling the overall quality process.

Course Learning Objectives:

1 To make a student understand the concept of JIT, types, their principles, economics and applications.
2 To know the implementation and production of different types of JIT for manufacturing systems. Also understand the process of Scheduling and Sequencing.
3 To learn about the sequential withdrawal system
4 The student is able to understand the concepts of Kanban system implemented in Toyota
5 Learn and understand the concept of production planning, production smoothing and demand fluctuation

UNIT I

Introduction and need of CPC
What CPC can do, CPC – getting the right tool JIT – Introduction – The spread of JIT Movement, some definitions of JIT, core Japanese practices of JIT, Creating continuous Flow Manufacturing, Enabling JIT to occur, Basics elements of JIT, Benefits of JIT

UNIT II

Just in Time
Primary purpose., profit through cost reduction, Elimination of over production, quality control, Quality Assurance, Respect for Humanity, Flexible work force, JIT, Production Adapting to changing production Quantities, purpose layout for shortened lead times, standardization of operation, Sequencing and scheduling used by suppliers – Monthly and daily information.

UNIT III

Sequenced withdrawal systems
By sequenced schedule table problems and counter measure in applying the kanban systems to sub contractors. Toyota Production Systems – The philosophy of TPS, Basics Frames Work of TPS, kanbans. Determine the Number of Kanbans in Toyota Production systems.

A) Kanban Number under constant Quality withdrawal systems
B) Constant Cycle, Non constant Quality Withdrawal Systems
C) Constant Withdrawal Cycle System for the Supplier Kanban

D) Examples A Detailed Kanban Systems Examples
Supplier Kanban and the sequencing Scheduled for the USE by Supplier
1) Later replenishment systems by Kanban
2) Sequenced Withdrawal systems
3) Circulation of the Supplier Kanban within Toyota

Production Smoothing in TPS, Production Planning, Production Smoothing, Adaptability to Demand fluctuation, Sequencing Method for the Mixed Model Assembly Line to Realize Smoothed Production

UNIT IV

JUST IN TIME Production

With Total Quality Control – Just in Time Concept, cutting purchase order cost the JIT cause – effect chain, scrape / Quality Improvement, Motivation effects responsibility effects, small group improvement activities withdrawal of buffer inventory The total quality control concept, The Quality Control Introduction – TQC concept, responsibility, learning from the west, TQC concepts, categorized, goals, habit of improvement, perfection, basics process control, easy to see quality control as facilitator, small lot size, house keeping. Less than full capacity scheduling, daily machine checking.

UNIT V

Techniques and tool

Exposure to problems, fool proof devices, tools of analysis QC circles, TQC in Japanese owned US Electronics plant TQC in Japanese owned Automotive plants. Plant configuration: Introduction ultimate plant configuration Job shop fabrication frame welding forming frames parts from tubing Dedicated production lines, overlapped production, the daily schedule, forward linkage by means of kanban, physical merger of process, Adjacency, mixed models automated production lines, Pseudo Robots, Robots, CAD and Manufacturing, Conveyors and stacker cranes, Automatic Quality Monitoring.

TEXT BOOKS:

1. Toyota Production system – An integrated approach to just in time – by Yasuhiro Monden
2. Lean Thinking – Byjames Wornack
3. The machine that changed the world – The story of lean production – By James P WornackHarper Perennial Edition Published 1991

REFERENCE BOOKS:

1. Japanese Manufacturing Techniques – By Richard Schonberger
2. Just in Time Manufacturing – Kargoanker
3. Wind chill reference manual Oxford university press,2005

Course Outcomes (COs):

Student will be able to

1. Demonstrate the concept of JIT their types, principles and application through real time examples[PO1,PO2,PO3,PO4 & PO5]
2. Assess types of JIT for different manufacturing system making scheduling and sequencing an easy process[PO1,PO2,PO3,PO4 & PO5]

3. Demonstrate sequential withdrawal system through real time examples[PO1,PO2,PO3,PO4 & PO5]
4. Have awareness of how Kanban is implemented in Toyota is enlightened to all users. [PO1,PO2,PO3,PO4 & PO5]
5. Distinguish between various chain initiative production planning and demand fluctuation. [PO1,PO2,PO3,PO4 & PO5]

ADVANCED MATERIALS TECHNOLOGY

Course Code: MSE E02 **Credits: 3:0:1**
Prerequisites: Nil
Course Coordinator: Dr. C SIDDARAJU

Preamble:
In day to day life we are coming across different types of materials pertaining to engineering field. We have conventional materials whose properties are already there in the hand books. As the new inventions are taking place, the conventional materials are being replaced with new one. So there is a need for newer materials which suits to the need, with improved properties and structures. And also there is a need for the newer materials with improved mechanical, chemical, electrical and other properties. This course deals with the study of such advanced materials to serve the required purpose in the field of aerospace, space craft and other areas where light weight and high strength are of interest.

Course Learning Objectives

1. To apply the knowledge in the field of materials and to differentiate with conventional and advanced material.
2. To assess different methods of powder production and to study different aspects related to powder metallurgy.
3. Explain the concepts of different production methods of composites.
4. To analyze micro and macro mechanics of composite material and assess various strength and stiffness parameters associated with it.
5. Characterize different types of titanium and nickel base super alloys and choose one which suits the application.

UNIT I

Development of Newer Materials: Properties of materials, Structure property relationship, newer materials-Ceramics and Composite materials, Ceramics- Types of ceramics, structure, processing methods and properties, applications. Composite materials – Types – Metal matrix Composites (MMC) Ceramic Matrix Composites (CMC) ,Polymer composites Structure.

UNIT II

Powder Metallurgy: Introduction, advantages and limitation of powder metallurgy. Characteristics of metal powders. Different methods of powder manufacturing, powder conditioning and compaction. Sintering, Finishing operations, Applications of PM components.

UNIT III

Processing of composites: Hand Layup techniques, Autoclave molding, Bag Moulding , filament winding Pultrusion, Pulforming, Thermoforming, Injection Moulding. Resin Transfer molding.

Cutting, machining and joining, tooling, Types of defects, NDT methods

UNIT IV

Micro mechanical analysis of lamina, Introduction, volume and mass fractions, density and void content, Evaluation of four elastic moduli.

Macro mechanical analysis of lamina. Introduction, review of definitions, Hookes Law of different types of materials. Hookes law for two dimensional unidirectional lamina, Invariant form of stiffness and compliance matrices for an angular laminate.

UNIT V

Titanium and its alloys: Production of titanium, properties, titanium alloy systems, Classification of titanium alloys, Alpha titanium alloys, Beta titanium alloys and some recent development in titanium alloys.

Nickel and cobalt alloys: Production, chemical composition, microstructure and properties of pure nickel. Nickel- copper alloys, Nickel- chromium alloys, Nickel base super alloys, Cobalt base super alloys; chemical composition, applications, microstructure, Strengthening mechanisms in single-crystal nickel base superlloys.

Laboratory Component:
Melting and pouring of metals, Metallographic study, Tensile test, Micro hardness test, Vickers hardness test, Airjet erosion test, Wear test, Impact test, Corrosion test, Density measurement.

REFERENCE BOOKS:

1. Materials and Processing in Manufacturing – E Paul Degarmo, J T Black, Ronald A Kohser. Pub 2006
2. Powder Metallurgy – A K Sinha.Sapna Publication, 2009
3. Composite Materials Hand book – M M Schwartz, McGraw Hill.
4. Rober M.Jones “Mechanics of composite Materials” McGraw Hill Kogakusha Ltd
5. Autar K. Kaw “ Mechanics of Composite materials” CRC Press ,1997.

Course Outcome (COs):

Students should be able to:

1. Apply the gained Knowledge in the field of material and to differentiate properties with respect to conventional material. [PO1,PO2,PO3,PO4 & PO5]
2. Select suitable powder production methods for different materials in order to get the required components. [PO1,PO2,PO3,PO4 & PO5]
3. Select suitable production technique for composite material. [PO1,PO2,PO3,PO4 & PO5]
4. Analyze and obtain stiffness and compliance matrix and also study strength parameters of lamina. [PO1,PO2,PO3,PO4 & PO5]
5. Decide the material to be used in aerospace and other high temperature application. [PO1,PO2,PO3,PO4 & PO5]

ADDITIVE MANUFACTURING

Course Code: MSE E03 **Credits: 4:0:0**
Prerequisites: Nil Course
Course Coordinator: Dr. JAYACHRISTIYAN K G

Preamble

The current marketplace is undergoing an accelerated pace of change that challenges companies to innovate new techniques to rapidly respond to the ever changing global environment. A country's economy is highly dependent on the development of new products that are innovative with shorter development time. Organizations now fail or succeed based upon their ability to respond quickly to changing customer demands and to utilize new innovative technologies. In this environment, the advantage goes to the firm that can offer greater varieties of new products with higher performance and greater overall appeal. At the center of this environment is a new generation of customers. These customers have forced organizations to look for new methods and techniques to improve their business processes and speed up the product development cycle. As the direct result of this, the industry is required to apply new engineering philosophy such as Rapid Response to Manufacturing (RRM). RRM concept uses the knowledge of previously designed products in support of developing new products.

Course Learning Objective

1. The aim of the course is to provide the students, with an opportunity to conceive, design, and implement products quickly and effectively, using the latest Additive Manufacturing methods and CAD/CAM technology
2. The students will be exposed to the development of AM Technology and its stages in the manufacturing arena
3. Technologies associated with material addition process are identified and its advantages are evaluated.
4. The students learn to differentiate various Design process parameters associated with Additive manufacturing technique
5. Selectively choose tooling techniques for a specific application

UNIT I

Additive Manufacturing, The Generic AM Process, AM Information work flow, AM – An Integral part of Time compression Engineering, The Benefits of AM, Distinction Between AM and CNC Machining.

Reverse Engineering Technology: Introduction, Reverse Engineering Hardware, Contact methods, Non contact Methods, Reverse Engineering Software.

Classification of AM Processes: Liquid Polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems, New AM Classification Schemes, Metal Systems, Hybrid Systems,

UNIT II

Vat Photo polymerization Processes: Introduction, Vat Photo polymerization Materials, Photo polymerization Process, **Powder Bed Fusion Processes**: Introduction, Materials, Powder Fusion Mechanisms, Process Parameters and Modeling, Polymer Laser Sintering, **Extrusion-Based Systems**: Introduction, Basic Principles, Fused Deposition Modeling from Stratasys, Materials, Limitations of FDM, Bio extrusion,

Software Issues for Additive Manufacturing: Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist AM.

UNIT III

Beam Deposition Processes: Material Delivery, Process Parameters, Typical Materials, **Direct Write Technologies**: Ink-Based DW, Laser Transfer DW., Thermal Spray DW, Beam Deposition DW., Liquid-Phase Direct Deposition, Beam Tracing Approaches to Additive/Subtractive DW., Hybrid Technologies,

Design for Additive Manufacturing: Design for Manufacturing and Assembly, Core DFAM Concepts and Objectives, AM Unique Capabilities, Exploring Design Freedoms, Design Tools for AM

UNIT IV

Direct Laser Cladding of AM: Fundamentals of Direct Laser Cladding., Fundamentals of the Laser Cladding Process, Material Aspects of Laser Cladding, Future Trends for Laser Cladding., Laser-Based Joining of Metallic and Non-Metallic Materials.

Laser-Based Joining of Metallic and Non-Metallic Materials: Lasers and System Technology for Welding, Laser Welding Parameters, Laser Welding of Different Materials, Limitations of Laser Welding., Laser Welding Process Control Tools, Innovations in Laser Welding,

UNIT V

Directed Energy Deposition Processes: Introduction, Material Delivery, Powder Feeding, Wire Feeding, Laser Based Metal Deposition Processes; Electron Beam Based Metal Deposition Processes. **Laser Rapid Manufacturing:** Laser Rapid Manufacturing of Low-Cost Tools, Laser Rapid Manufacturing of Porous Materials., Laser Rapid Manufacturing of Bimetallic Components, Laser Surface Melting Treatment for Enhanced, Fundamental Aspects of Laser Material Processing., Polymer Materials, Joining with Laser Beams

TEXT BOOKS:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
3. Rapid manufacturing, Fiham D.T & Dinjoy S.S Verlog London 2001.
4. Rapid Prototyping: Principles and Application…(Hardcover) by Rafiq I. Noorani
5. Laser-Induced Materials And Processes For Rapid Prototyping, L.Lii, J. Y. H. Fuh, y.s. Wong, Kluwer Academic Pub1ishers in 2001.

REFERENCE BOOKS:

1. Rapid prototyping, Terry Wohler's Report 2000" association 2000.
2. Rapid prototyping materials by Gurumurthi. IISc Bangalore.
3. Rapid automated by lament wood. Indus press New York.

Course Outcomes (COs):

1. The students will learn about a working principle and construction of Additive Manufacturing technologies [PO1,PO2,PO3,PO4 & PO5]
2. The students will potential to support design and manufacturing, modern development in additive manufacturing process [PO1,PO3,PO4 & PO5]
3. The student can assess and implement AM techniques for specific application leading to better ROI for the company that uses Laser AM machines [PO1,PO2,PO3,PO4 & PO5]
4. The students can enhance the production sequence of tooling process by choosing the correct material for the job[PO1,PO2,PO3,PO4 & PO5]
5. The students are in a position to incorporate the productivity sequence by choosing the right AM technology.[PO1,PO2,PO3,PO4 & PO5]

SIMULATION AND MODELING OF MANUFACTURING SYSTEMS

Course Code: MSE E04 **Credits:4:0:0**
Prerequisites: Nil
Course Coordinator: Dr. HEMAVATHI S

Preamble:

Simulation is the method of generating the actual process in a virtual environment. This involves generating mathematical models to simulate the manufacturing systems. Simulation helps to reduce the experimentation costs and time. It provides the user with the approximate results in optimum time. Simulation can solve a wide range of problems ranging from simple queuing to complicated problems in a production environment.

Course Learning Objectives

1. To understand the need for simulation and modeling in manufacturing sectors
2. To understand and analyze the problems related to Queuing Systems in a Production Setup
3. To understand and analyze the problems related to Reliability and Inventory Systems in a Production Setup
4. To understand and analyze different issues in Manufacturing and Material-Handling Systems
5. To gain knowledge about verification and validation of the simulation packages

UNIT I

Introduction to Simulation:
Definition of Simulation, Types of Simulation, Difference between Simulation & Experimentation; History of Simulation
Brief Description of Monte-Carlo Simulation, Limitations of Simulation, Areas of Applications
System and Environment: Components of a System; Discrete and Continuous Systems

UNIT II

Queuing Simulation:
Description of Discrete Event Simulation; Simulation of Single Channel Queue and Two Channel Queue – General Applications and Production Environment Applications; Simulation of Lead-Time Demand;

UNIT III

Reliability, Inventory & Event Scheduling:
Simulation of Reliability Problems & Inventory Problems; Even Scheduling Algorithm – Single Channel Queue and Two Channel Queue; Simulation of an Activity Network

UNIT IV

Simulation of Manufacturing and Material-Handling Systems:
Models of Manufacturing Systems; Models of Material-Handling Systems; Goals and Performance Measures; Issues in Manufacturing and Material-Handling Simulations; Assembly Line Simulation

UNIT V

Verification and Validation of Simulation Models:
Model-Building, Verification and Validation, Verification of Simulation Models, Calibration and Validation of Models- Face Validity, Validation of Model Assumptions, Validating Input-Output Transformations;
Simulation Software: Selection of simulation software, simulation packages.

TEXT BOOKS:

1. Jerry Banks & John S Carson II, "Discrete Event System Simulation". Prentice Hall Inc. 1984.
2. Gordan. G. "Systems Simulation", Prentice Hall India Ltd, 1991.
3. NusingDeo, "System Simulation with Digital Computer", Prentice Hall of India 1979.

REFERENCE BOOKS:

1. Francis Neelamkovil, "Computer Simulation and Modeling", John Wilely& Sons,1987.
2. Rath M. Davis & Robert M O Keefe, "Simulation Modeling with Pascal'. Prentice Hall

Course Outcomes (COs):

Students will be able to

1. Remember the significance and applications of various methods of Simulation. [PO1,PO2,PO3,PO4 & PO5]
2. Understand the difference between Experimentation & Simulation and the concepts of Verification & Validation of Simulation Models. [PO1,PO2,PO3,PO4 & PO5]
3. Apply the simulation concepts of Single and Two Channel Queue Systems appropriately to various problems in a production setup. [PO3,PO4 & PO5]
4. Analyze the Inventory Scenarios and propose necessary Event Scheduling solutions. [PO3,PO4 & PO5]
5. Evaluate the Reliability of machineries and processes in a production environment. [PO3,PO4 & PO5]

FLEXIBLE MANUFACTURING SYSTEMS

Course Code: MSE E05 **Credits: 4:0:0**
Prerequisites : Nil
Course Coordinator: Dr. SRIDHAR B S

Preamble:

This subject helps the student to learn about the importance of Flexible Manufacturing system its configurations and different types of FMS layouts available for different industries. It also helps the student to learn multi-disciplinary concepts like, JIT, KANBAN, GT, DNC, Material handling systems, Retrieval systems, Sequencing, schedule and loading of the FMS systems. Finally the subject helps to understand and interpret technically and economically the use of FMS.

Course Learning Objectives:

1. To know the differences between conventional and flexible manufacturing systems in manufacturing industries.
2. To learn the different types of automated material handling systems, design of conveyor and AGV and AS/RS systems.
3. To be able to understand the concepts of JIT, KANBAN and GT in a FMS system.
4. To learn the different types of scheduling and loading methods.
5. To know the tool management, economical and technological justification for FMS.

UNIT I

FMS-An overview : Definition of FMS- Types and configurations concepts – types of flexibility and performance measures. Function of FMS host computer – FMS host and area controller function distribution, Development and implementation of an FMS: Planning phase – integration – system configuration – FMS layouts – Simulation – FMS project development steps.

UNIT II

Automated material handling and storage systems: Functions – types – analysis of material handling equipments, design of conveyor and AGV systems, Problems, Automated storages: Storage system performance, AS/RS Carousel storage system. WIP storage system interfacing handling storage with manufacturing

UNIT III

JIT, KANBAN and GT System: Introduction, Definition, JIT Concept, Goals of JIT, Quality and Quantity Principles of JIT, JIT Implementation. Kanban/Card System, Push vs. Pull System, Types of Kanban. Group Technology, Introduction, Reasons for Adopting Group Technology, Benefits, Obstacles to Application of GT.

UNIT IV

Scheduling and loading of FMS: Introduction - Scheduling rules, Scheduling of operations on a single machine, 2 machine flow shop scheduling, 2 machine job shop scheduling, 3 machine flow shop scheduling, scheduling ‘n’ operations on ‘m’ machines, problems on loading of FMS.

Distributed Numerical Control (DNC): DNC system, general configuration and components of DNC system, different modes of DNC communication, Hierarchical processing of data in DNC

UNIT V

Tool management of FMS: Tool management, tool strategies, Tool Preset, Identification and Data Transfer, Tool Monitoring and Fault Detection, Experimental Setup and Data Collection, Relational, economical and technological justification of FMS, typical case studies of FMS implementation.

TEXT BOOKS:

1. Parrish D J, Flexible manufacturing, Butterworth – Heinemann, Ltd Oxford, 1993
2. Groover M P, Automation, production system and computer integrated manufacturing, PHI, 1989
3. Kusiak A, Intelligent Manufacturing systems, prentice hall, Englewood Clitts, NJ, 1990
4. William W Luggen – Flexible Manufacturing Cells and systems, PH, NJ

REFERENCE BOOKS:

1. Considine D M and Considine G D, Standard handbook of industrial automation, Chupman and Hall, London, 1986
2. Vishwanatham N and Narahari Y, peroformance modeling of automated manufacturing Systems, PHI, 1992
3. Ranky P G, The design and operation of FMS, IFS publication, UK, 1988
4. Dr. H K Shivanand, "Flexible Manufacturing System" – Dhanpat Rai Publication, New Delhi.

Course Outcomes (COs):

The student will be able to;

1. Understand the concept of FMS and automation in conventional manufacturing system. [PO1,PO2,PO3,PO4 & PO5]
2. Synchronize the machineries with material handling and retrieval systems. [PO1,PO2,PO3,PO4 & PO5]
3. Able to apply concepts of JIT, KANBAN and GT in a FMS system. [PO1,PO2,PO3,PO4 & PO5]
4. Able to perform different types of scheduling and loading techniques in production system. [PO1,PO2,PO3,PO4 & PO5]
5. They will be finally able to economically and technically justify the application of FMS and tool management. [PO1,PO2,PO3,PO4 & PO5]

FEM FOR MANUFACTURING

Subject Code : MSE E06 **Credits: 3:0:1**
Prerequisites : Nil
Course Coordinator: Dr. P DINESH

Preamble

Finite Element Method is proving to be a very powerful technique of solving and analyzing complex engineering problems. It is a numerical method which yields fairly accurate results for complex engineering problems and of late has emerged as a very rapidly growing area of research for applied mathematics. Its usefulness in various branches of engineering is due to the ease with which the method is made amenable to computer programming, leading to a process of iterative design.
Its uniqueness lies in the fact that complex engineering problems having no analytical solutions can be solved with ease and iterative designs can be worked out.
Of late, this technique has found a lot of applications in the area of manufacturing as newer and specialized techniques and materials are being used with changing technology. In this context it is desirable to introduce the subject of FEM in the curriculum of PG courses related to manufacturing so as to train the students for developing skills for designing and analyzing the various manufacturing processes for an optimized process. The method can also be used in the development of machine tools, newer materials and failure analysis of processes.

Course Learning Objectives

1. To introduce fundamentals of elasticity, plasticity and mechanics of metalworking.
2. To learn the fundamental concepts of variational methods and weighted residual methods, to solve problems of beams and bars and understand fundamentals of space and planar frames. and bending of thin plates.
3. To understand the fundamentals of heat transfer and dynamic problems and solve related problems.
4. To learn and understand the fundamentals of axisymmetric elements, shell elements and bending of thin plates and non linear FEM analysis.
5. To develop competence in solving real life engineering problems using commercial FE software.

UNIT I

Elasticity fundamentals: State of stress and strain at a point, equations of equilibrium, compatibility conditions, elastic stress strain relations
Plasticity fundamentals: Material models, yield criteria, methods of analysis of mechanics of metal working processes.

UNIT II

Review of fundamentals of FEM, variational and weighted residual methods, 1D Problems based on Rayleigh Ritz and Galerkin's methods. Analysis of beams and trusses Fundamentals of space and planar frame elements.(elementary treatment only)

UNIT III

Straight fin analysis using linear and quadratic elements Hamilton's principle, derivation of mass matrices of bar and beam elements, deriving Eigen values and Eigen vectors for free vibrating bars.(elementary treatment only)

UNIT IV

Axi-symmetric formulation for axi-symmetric loading, triangular element (simple problems).
Shell elements, forces on shell elements, types of elements and solid shell elements bending behaviour of thin plates.(elementary treatment only)

UNIT V

Non linear FEM, nonlinear problems such as material non linearity, geometric nonlinearity and material and geometric non linearity, analysis procedures.

Lab Components
1D problems: Problems on Bar – Truss – Beams – Dynamic Analysis
2D problems: problems on Plate
3D problems: CAD to CAE – Exercise on machine elements.

TEXT BOOKS:

1. Introduction to Finite Element in Engineering, RChandrupatla and Ashok Belegundu, Prentice Hall India Pub 2006.
2. The Finite Element Methods in Engineering – S.S. Rao, Butter Worth Heinemann, Pub 2005.
3. Hybrid Modelling and Optimization of Manufacturing, Quiza R et.al, Springer –Verlag Berlin Heidelberg, Pub. 2012
4. Finite Element Analysis, S.S.BhaviKatti, New Age International Publishers, 2015

REFERENCE BOOKS:

1. Finite Element Analysis Theory & Programming - C S Krishnamurthy – Tata McGraw Hill, Pub 2000.
2. The Finite Element Method – Zienkiewicz, O C-Tata McGraw Hill, Pub 1979.

Course Outcomes (COs):

The student will be able to:

1. Understand basics of theory of elasticity, plasticity and mechanics of metal working. [PO1,PO2,PO3,PO4 & PO5]
2. Understanding the variational and weighted residual methods and solve problems on bar, beams, trusses and have an understanding of planar and space frames. [PO1,PO2,PO3,PO4 & PO5]
3. Demonstrate ability and skill to solve problems of heat transfer and Dynamic problems. [PO1,PO2,PO3,PO4 & PO5]
4. Develop understanding of axi-symmetric, shell and thin plate elements and non linear FEM analysis. [PO1,PO2,PO3,PO4 & PO5]
5. Demonstrate the ability to solve real life 1D, 2D and 3D problems using commercial FE software. [PO1,PO2,PO3,PO4 & PO5]

MECHATRONICS AND MEMS

Course code: MSE E07 **Course Credits: 3:0:1**
Prerequisites: Nil
Course Coordinator: Dr. R KUMAR

Preamble:
Mechatronics, which is also called mechatronic engineering, is a multidisciplinary branch of engineering that focuses on the engineering of both electrical and mechanical systems, and also includes a combination of robotics, electronics, computer, telecommunications, systems, control, and product engineering. As technology advances over time, various subfields of engineering have succeeded in both adapting and multiplying. The intention of mechatronics is to produce a design solution that unifies each of these various subfields. Originally, the field of mechatronics was intended to be nothing more than a combination of mechanics and electronics, hence the name being a portmanteau of mechanics and electronics; however, as the complexity of technical systems continued to evolve, the definition had been broadened to include more technical areas.

Course Learning Objectives:-
At the end of the course the student will be able to

1. Define Mechatronics systems and recognize its various elements.
2. Compile the key elements of signal conditioning circuits.
3. Express the concepts of actuation systems.
4. Express the concepts of programming logic controllers.
5. Understand the concept of MEMS

UNIT I

Mechatronics, Sensors nd Transducers: Introduction to Mechatronics Systems, Measurement Syste ms Control Systems Microprocessor based Controllers. Sensors and Transducers – Performance,Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion,Force, Fluid Pressure, Liqu id Flow, Liquid Level, Temperature, Light sensors selection of sensors.

UNIT II

Signal Conditioning: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, wheat stone bridge, digital signals Multiplexers, data acquisition, Introduction to Digital system processing pulse modulation, Numerical problems

UNIT III

Actuation System: Electrical Actuation Systems - Mechanical Switches – Solid State Switches, Solenoid Construction and working principle of DC and AC Motors speed control of AC and DC drives, Stepper Motors-switching circuitries for stepper motor – AC & DC Servo motors. Introduction to Hydraulic and Pneumatic actuation systems and their application

UNIT IV

Micro Electro Mechanical Systems (MEMS) : Introduction –MEMS, MEMS micro sensor, Mems micro actuator, manufacturing processes of MEMS, commonly used MEMS micro sensors, Advantages and applications of MEMS.

UNIT V

Programmable Logic Controllers:

Programmable Logic Controllers– Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers- Master and Jump Controls – DataHandling – Analogs Input / Output – Selection of a PLC.

Experiments on Home automation with the application of PLC.

Lab Component

Experiments on Home automation with the application of PLC

TEXT BOOKS:

1. Mechatronics- W. Bolton, Longman, 2nd Pearson Publications, 2007
2. Microprocessor Architecture, programming and applications with 8085.8085A- R.S. Ganokar, Wiley Eastern.

REFERENCE BOOKS:

1. Mechatronics Principles & applications by Godfrey C. Canwerbolu, Butterworth- Heinemann 2006.
2. Mechatronics- danNecsulescu, Pearson Publication, 2007
3. Introduction Mechatronics & Measurement systems, David. G. Aliciatore & Michael.B. Bihistand, tata McGraw Hill, 2000. Mechatronics : Sabricentinkunt, John wiley& sons Inc. 2007

Course Outcomes (COs):

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

1. Define Mechatronics systems and recognize its various elements. [PO1,PO2,PO3,PO4 & PO5]
2. Compile the key signal conditioning circuits. [PO5]
3. Demonstrate the concepts of system models and controllers. [PO1,PO2,PO3,PO4 & PO5]
4. Understand the concepts of programming logic controllers. [PO1,PO2,PO3,PO4 & PO5]
5. Understand the concepts of MEMS. [PO1,PO2,PO3,PO4 & PO5]

MACHINE LEARNING AND PYTHON

Course Code: MSE E08 **Course Credits: 4:0:0**
Prerequisite: Probability, Statistics
Course Coordinator: Dr. JAYACHRISTIYAN K G

Preamble
Machine learning is about designing programs that can learn without being explicitly programmed. It is a branch of Artificial Intelligence in which we learn concepts/patterns/hypotheses from Data by using heuristic based algorithms. Accordingly, this field is about study and implementation of two main category of algorithms: Supervised and Unsupervised. Supervised learning algorithms make use of data with known classification, aka labeled examples whereas Unsupervised learning algorithms use data with unknown classification, aka unlabeled examples. This field has become so popular that one can find machine leaning applications in virtually all domains ranging from identifying emails as spam or legitimate to automated vehicle guided system to game playing to credit card fraud detection. As this form is unlikely to become exact science, a learning method/algorithm needs to be evaluated and estimated for its performance on unseen data or the population.

Course Learning Objectives
1. To introduce students to the Read and write simple Python programs.
2. To make students learn the basics of machine learning and apply concept learning to real time scenarios.
3. To give an introduction to working of Decision trees.
4. To understand the importance Bayesian learning algorithm and its variants, Instance based learning.
5. To learn the role of concept learning, Bayes classifier, k nearest neighbour, Regression.

UNIT I

Introduction, Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: while, for.

UNIT II

Strings: string slices, immutability, string functions and methods, string module. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters. Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods.

UNIT III

What is Machine Learning, Benefits, opportunities and risk for the mechanical engineering, Well-posed learning problems, Designing a learning system, Perspectives and Issues, a concept learning task, Concept learning as search, Find-S: Finding a maximally specific hypothesis, Version spaces and candidate elimination algorithm.

UNIT IV

Decision tree learning: Representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, Introduction to Linear and Non-Linear regression

UNIT V

Bayes Theorem and Concept learning, Maximum Likelihood and Least Squared Error, Maximum Likelihood hypotheses for predicting probabilities Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Instance based learning: k-nearest neighbor learning, Locally weighted regression

TEXT BOOKS:

1 Think Python: How to Think Like a Computer Scientist Allen B. Downey Shroff O'Reilly Publishers 2nd edition 2016
2 An Introduction to Python – Revised and updated for Python 3.2 Guido van Rossum and Fred L. Drake Jr Network Theory Ltd., 2011
3 Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013

REFERENCE BOOKS:

1 Introduction to Programming in Python: An Inter-disciplinary Approach Robert Sedgewick, Kevin Wayne, Robert Dondero Pearson India Education Services Pvt. Ltd 2016
2 Fundamentals of Python: First Programs Kenneth A. Lambert CENGAGE Learning 2012
3 EthemAlpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

Course Outcomes (COs):

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

1. Read and write by hand simple Python programs. [PO1,PO2,PO3,PO4 & PO5]
2. Outline the preliminaries of machine learning and apply concept learning to real time scenarios. [PO1,PO2,PO3,PO4 & PO5]
3. Illustrate the working of Decision trees. [PO1,PO2,PO3,PO4 & PO5]
4. Describe Bayesian learning algorithm and its variants, Instance based learning. [PO1,PO2,PO3,PO4 & PO5]
5. Investigate concept learning, Bayes classifier, k nearest neighbor, Regression. [PO1,PO2,PO3,PO4 & PO5]

CONDITION BASED MONITORING

Course Code: MSE E09 **Credits: 3:0:1**
Prerequisites: Nil
Course Coordinator:Dr C M RAMESHA

Preamble:
Condition Based Maintenance (CBM) is continually evolving its conceptual basis which can be traced back to the earliest development of machinery, and the use of human senses to monitor the state of Industrial equipment. In today's industry augmented by scientific and sophisticated instrumentation.CBM is widely employed in sophisticated instrumentation allows the quantification of the health or condition of industrial machinery and equipment, so that problems can be diagnosed early in their development and corrected by suitable maintenance, before they become serious enough to cause failure and plant breakdown.

Course Learning Objectives:
To make a student

1. Understand the basic concept about of Maintenance and condition based maintenance, types, their principles, economics and applications.
2. Implementation of different types of monitoring techniques applicable to various manufacturing systems.
3. Understand general concept of NDT and their application and specialized techniques used in CBM and their importance in modern plants
4. Understand the monitoring technique incorporated in Bearings, concept of condition monitoring technique by case studies included in bearing failure, history of failure, Analysis of failure, faulty detection and symptoms and monitoring of cracks, misalignment and vibration monitoring.
5. To Analyze and understand trend monitoring techniques, performance parameters with appropriate case studies and examples.

UNIT I

Condition based Maintenance: Introduction, principles, classification of maintenance, types of maintenance, Economics in maintenance. Condition Monitoring Methods, Economics of condition monitoring, sets up a condition Monitoring Activates. Implementation of condition based Maintenance, Information Systems, selection of Monitoring Methods, Assessment of Monitoring techniques, case studies. Consequences of implementation of CBM

Non –Destructive testing and Specialized techniques: Introduction, visual testing, liquid penetrate inspection, Water washable method.. Pre-cleaning, penetrate application, Dwell time, surface drying, Developer application, Dwell time, Excess surface penetrate removal, Interpretation, Post-emulsifiable penetrates, Solvent-soluble penetrates**.**

UNIT II

Radiographic examination: X-Ray apparatus, X-Ray generation, Tube Shielding Control console, Other X-Ray Sources, Electrostatic or VenDegraffgenerators, Linear accelerators. Gamma –Ray Radiography, Sources –Radium, Thallium 170, Iridium 192, cobalt 62.Isotope Projectors- geometric factors, Radiographic film, Radiograph, safety hazards and Government control
Ultra Sonic's Examination: Ultrasonic triangulation fault location acoustic emission technique (AET) – Instrumentation, Transducers, Preamplifier and filter, Main amplifier, and signal processing

display unit, Signals and processing, Magnetic testing Methods, current flow magnetization, Induction Magnetic flow method, Induction threading bar method, Induction Magnetizing coil method, Induced current flow method, Magnetic particle Inspection links, strippable Magnetic film,

UNIT III

Vibration Monitoring and Analysis: Introduction to vibration monitoring, Machinery vibration signatures, selection of transducers. Analysis techniques, Machine failure modes, Measurement location, Vibration severity criteria, Vibration frequency analysis. Permanent monitoring, case studies.

Vibration Monitoring of ball and roller bearings: Introduction, shock pulse method (SPM), SPM for testing Antifriction bearings, Manual monitoring. Continuous monitoring, the kurtosis method, Fiber optics system, Vibration signature analysis, contact resistance method, case studies. SPM and its applications

UNIT IV

Condition Monitoring case studies & Applications: Failure of fan bearings, History of failures, Analysis of the failures, solution. High frequency vibration of gas compressor – History of trouble, Analysis of trouble, solution. Monitoring of cracks in rotors – Turbo compressor misalignment. Detection of faulty electrical components. Turbine shell distortion. Symptoms and Detections

Thermography and Performance Trend Monitoring: Eddy current apparatus, cost. Thermography- thermo graphic Equipment, application of thermography. Introduction to steam turbine performance parameters, case studies and Examples.

UNIT V

Corrosion Monitoring and wears monitoring: Need for corrosion monitoring, fields of application, Monitoring Techniques, Resistance Techniques. Other probe techniques- Analytical technique and others. Wear process monitoring techniques – Direct debris detection methods, Debris collection methods.

Lubricant analysis: Introduction, source of contamination, significant oil contaminants, used oil contamination-time trends, changes in the carrier fluid, erratic wear debris. Lubricant sampling methods, Lubricant analysis methods, interpretation of results, indications from the amount of debris present, indication from the size distribution of debris, Application of chemical analysis of debris, wears detection using proximity monitors, case studies.

LAB COMPONENTS: NDT, Surface Roughness Monitoring**,** Vibration Monitoring, Corrosion monitoring, Pressure monitoring, Temperature monitoring, Lubrication Monitoring, Ultrasonic Examination, thermography, Visual Inspection, Liquid Penetrant Inspection, Experimentation using Dilatometer, XRD, TGA and FTIR.

REFERENCE BOOKS:

1. L. F. Pau Marcel Dekker “Failure Diagnosis and Performance Monitoring”.
2. Condition Monitoring and condition based maintenance ”Current Literature. Update CEP ISTE New Delhi “
3. Hand Book of condition Monitoring: Techniques and Methodology: Davis.A. Chapman & Hall,Madras, NewYork, Tokyo, Mellborne.
4. Mechanical Fault Diagnosis and Condition monitoring R. A. Caollacatt , Chapman and hall 1977.
5. Hand book of condition monitoring B K N Rao . Elsevier 1st Edition 1996 .\

6. Machinery condition Monitoring , principles and Practiceses , Amiya Ranjan Mohanty- 2014, CRC Press.

Course Outcomes (COs):

At the end of the course students are able to

1. Understand the concept of Maintenance and condition based maintenance, types, their principle, economics and applications. [PO1,PO2,PO3,PO4, & PO5]
2. Identify the advanced NDT methods like Radiographic examination and Ultrasonic examination used to improve the availability, maintainability of the modern plant for optimal running condition. [PO1,PO2,PO3,PO4,& PO5]
3. Understand general concept of NDT and their application and specialized techniques used in CBM and their importance in modern plants [PO1,PO2,PO3,PO4, & PO5]
4. Understand the monitoring technique incorporated in Bearings, concept of condition monitoring technique by case studies included in bearing failure, history of failure, Analysis of failure, faulty detection and symptoms and monitoring of cracks, misalignment and vibration monitoring. [PO1,PO2,PO3,PO4, & PO5]
5. Analyze and understand trend monitoring techniques, performance parameters with appropriate case studies and examples. [PO1,PO2,PO3,PO4, & PO5]

TOOLING FOR MANUFACTURING IN AUTOMATION

Subject Code: MSE E10 **Credits: 3:0:1**
Prerequisites: Nil
Course Coordinator: Dr. LOKESHA K

Preamble:

Rapid developments are taking place in the field of manufacturing processes, the exotic and complicated machinery and new products are appearing in the market. Tool design is a specializes area of manufacturing engineering which comprises the analysis, planning, design, and the application of tools, methods and the procedures to increase the manufacturing productivity. For this, a tool designer has to have a working knowledge of machine shop practice, tool making procedures, machine tool design, etc. Tooling refers to the hardware necessary to produce a particular product. Tooling as viewed by the tool designer consists of a vast array of cutting tools, devices, jigs, fixtures, dies, gauges for measurement etc., used for manual production with the development of new materials, need for higher dimensional accuracy, high production rate, a need for development of individual requirements with respect to tooling arose. This has resulted in various new techniques and replacement of the conventional fixtures, clamping devices etc.

Course Learning Objectives:

1. The students are introduced to the need for pre-design analysis, fixtures and jigs, principles for locating, positioning, clamping.
2. To evaluate and analyze the differences between the conventional technologies and NC machine tools.
3. To understand the sheet metal fabrication methods and understand the concept of simple dies, compound dies and progressive dies.
4. To understand the injection moulding methods
5. To understand the different gating systems, runner and gating design, the concept of ejection, cooling systems, types, shrink analysis and analyze the fluid flow in moulds.

UNIT I

Design of Jigs & Fixtures: Pre-design analysis, fixture design procedure principles of locating and positioning, clamping and positioning, tooling for drilling and reaming processes. Milling fixture design, fixture for twining, boring & grinding.

UNIT II

Tooling for Numeral Control Machine Tool: Special design considerations, modular fixture design, modular tooling system. Other NC tooling. Tooling for Flexible manufacturing systems.

UNIT III

Design of Tools for sheet metal operations: Design of sample, compound and progressive dies, Design of strip layout. Die materials, press selection, Die design for sheet metal forming, cutting and SMED principles.

UNIT IV

Design of Thermoplastic Injection Mould Design: Product and mould, fluid flow, machine and its influence on mould design. Two plates and Three plate moulds. Runner and gate design. Runner less and undercut moulds. Mould cooling. Ejection methods, Prototype moulds. Mould Tool materials.

UNIT V

Part and Mould Design Optimization: Part and mould design, simulation-static, dynamic and thermal analysis of thermoplastic parts and injection moulds. Analysis of Thermo Plastic and Rubber Moulds: Cool, wrap, shrink analysis, locating of weld lines. Mould materials.

Lab Components

Model 1: Jig – Design, Process Plan, Manufacturing process, Assembly
Model 2: Fixture - Design, Process Plan, Manufacturing process, Assembly
Model 3: Modular tool device (Demo)
Model 4: Injection mould – Design, Process Plan, Assembly
Model 5: Press tool– Design, Process Plan, Assembly

REFERENCE BOOKS:

1. William E Boyes, "Handbook of Jig and Fixture Design", Second Edition, SME, Michigan, 1989.
2. Cracknell P S and Dysor R W, "Handbook of Thermoplastic Injection Mould Design", Blackie Academic & Professional, Glasgow, 1993.
3. SME, "Tool and Manufacturing Engineers Hand Book", Vol.II-Forming Fourth Edition, 1984.
4. Nagpal, "Tool design"
5. P H Joshi, "Jigs & Fixtures", TMH Publications.

Course Outcomes (COs):

Student will be able to

1. Understand, identify and adopt new techniques of jigs and fixture for an industrial application. [PO1,PO2,PO3,PO4,& PO5]
2. Acquire and demonstrate the need of numerical control machine tools for a manufacturing sector. [PO1,PO2,PO3,PO4,& PO5]
3. Adopt the concept and applications of dies in sheet metal fabrication. [PO1,PO2,PO3,PO4,& PO5]
4. Adopt the concept and applications of dies in injection moulding for plastic component manufacturing. [PO1,PO2,PO3,PO4,& PO5]
5. Understand the various mould defects and acquire basic knowledge on mould flow analysis. [PO1,PO2,PO3,PO4,& PO5]

NANOTECHNOLOGY

Course Code: MSE E11 **Credits: 4:0:0**
Prerequisites: Nil
Course Coordinator:Dr PRAKRATHI S

Preamble

The world of materials science is witnessing a revolution in the exploration of matter at the small scale. Sub-atomic particles have been a fascination since the first half of the 20th century. The science of nanometer scale objects is nanoscience. The resulting technology is called nanotechnology. Nanotechnology involves achieving the capability to manipulate matter in a desired fashion, atom by atom. At this scale, the constituents of matter do functions, which are different from those of the constituents or bulk materials. The course introduces the fundamental concepts, principles, fabrication, characterization and application of nanomaterials

Course Learning Objective

At the end of this course, the student would be able to understand

1. The Physics & Chemistry of Nano Science
2. The Semiconductor Nanostructures
3. The method of Fabrications and characterization of Nanostructures
4. Nano Tribology
5. Nanomechanical properties

UNIT I

Introduction: Overview of Nanoscience and Nanotechnology, Classification of nanostructures, Nanoscale Architecture, Scaling and miniaturization laws

Electronics Properties Of Atoms and Solids: The isolated atom - Bonding between atoms - LCAOs. - Van der Waals forces- Dispersion interaction - Orientation interaction _ Induction interaction, Stating Schrodinger's wave equation and its importance - Physical significance of wave function - Eigen values and Eigen functions. The Free electron (particle) model and energy bands-particle in 1¬ D potential well of infinite height (discussion on energy values, wave functions - normalization and probability densities), Particle in 1- D potential well of finite height - Concept of tunneling- Heisenberg's uncertainty principle- Derivations of density of states for 3D, 2D, I D and OD, and graphical representations.

Effects of Nanometer Length Scale: Changes to the system total energy, Changes to the system structure, Effect of nanoscale dimensions on properties- structural, thermal, Chemical, mechanical, magnetic, optical and electrical.

Inorganic Semiconductor Nanostructures: semiconductor, doping, concept of effective mass, Carrier transport, mobility and electrical conductivity, Optical property of semiconductors, The P-N junction, Phonons, Types of semiconductors

Quantum Confinement in Semiconductor Nanostructures: Quantum confinement in one dimension- quantum well; Quantum confinement in two dimensions- quantum wires; Quantum confinement in three dimensions- quantum dots, Super lattices, band offsets.

UNIT II

Fullerenes: structure and synthesis, chemical reactivity-Chemistry of higher fullerenes-applications.

Nanotubes: carbon forms structured by energetic species-amorphous nanotubes and crystalline forms, Carbon- an ideal model system to study structuring by energetic species, structuring of

amorphous carbon forms, structuring of ordered Sp_2 forms, structuring carbon forms. Synthesis and purification of multiwalled and single walled carbon nanotubes: Electric arc (arc evaporation) technique, laser ablation, catalytic decomposition of hydrocarbons purification. Structure and properties of carbon nanotubes, Inorganic nanotubes- structure, synthesis and properties. Electron transport in nanotubes, Ballistic, Spintronics, Coulomb blockade and Nano wires, Organic semiconductors, Organic light emitting diodes.

Self-Organization: Phase behavior of Nano particle suspensions, hard sphere Behavior, soft repulsions, and weakly attractive suspensions.

Catalysis: Nano crystalline zeollites- Hydrothermal synthesis of nanocrystallinezeollites-application in environmental catalysis, selective partial oxidation reactions of hydrocarbons and photo catalytic decomposition of organic contaminations using nanocrystallinezeollites.

Nanoclusters- Properties and applications in catalysis.

Surface and Interface Chemistry: Colloid systems - Colloids theory of coagulation, micells, nanocrystals and their super lattices. Background of the measurement of surface forces and interface forces. Optical, thermal and magnetic properties of nanomaterials: Applications- Biosensors, Optical tweezers, Paints Laser materials, Membranes and mesoporous materials, Water Purification. Molecular motors, Nanospring, Nanobalance. Atomic manipulation - Quantum corrals, Quantum mirage.

UNIT III

Fabrications of Nanostructures: Top-Down Processes-Milling; Silicon VLSI fabrication processes - Doping, Oxidation / Deposition, Etching; Lithographic processes - Photo, e-beam, Focused ion beam, X¬-ray: Soft Lithography; Machining - Micromachining, Micromachining, and LlGA. (MEMS processes); Applications- Nano- and Micro-machines (NEMS and MEMS) Nanotube FET, Interconnects and Electron emitters

Bottom - Up Processes: Vapor deposition methods - MBE, OMVPE; Hetrostructures, Quantum Wells, Multiple Quantum Wells; Quantum Wires and Quantum Dots; Modulation doping devices, Resonant Tunneling Devices;

QWIP, Quantum Well lasers, photonic crystals, Nano computing; Liquid Phase methods - molecular and biological computing; Colloidal methods; Sol-gel methods; Electrodeposition; Self-assembly and self-organization processes

UNIT IV

Basics Of Scattering Physics Related to Characterization:

X-rays and their interaction with matter,electron and their interaction with matter, Phonon scattering, Plasmon scattering, Single-electron excitation, direct radiation losses, Neutrons and their interaction with matter, Ions and their interaction with matter. Elastic scattering and diffraction.

Technology of Characterization:

Profilometry, Optical microscope, SEM, TEM, FIB, STM, AFM, Surface Raman Scattering, Wettability (contact angle) measurements, Small angle X-ray diffraction and electron diffraction

UNIT V

Nanotribology: Composition and structure of surfaces natural condition: oxide and hydrocarbon films surface segregation and reaction with environments, thermodynamics structure of surfaces, atomistic simulations methods to study composition and structure of surfaces composition -Auger electron spectroscopy, X -ray photoelectron spectroscopy

Structure-LEED,STM/AFM,XRD,HRE, Chemical interactions on surfaces, adsorption and deposition on surfaces (physisorption and chemisorption); Langmuir adsorption isothenn, desorption from surfaces: Electronic properties and surface reactions relevant to tribology, density functional studies analysis structure sensitivity lubricant degradation.

Nanomechanical properties: Determination of surface mechanical Properties (AFM/ nanoindentation), simple friction theories -effects of surface composition and structure: on friction environmental and temperature effects, relationship with surface chemistry, mixed and boundary lubrication, failure mechanisms.

REFERENCE BOOKS:

1. Handbook of Nanoscience Engineering and Technology, Ed. William A. Goddard III, Donald W.Brenner, Sergey EdwartLyschevski and Gerald J.Iafrate, CRC Press, New York (2003).
2. Microlithography Fundamentals in Semiconductor Devices and Fabrication Technology, by Ueno T., Ito T. and Nonogaki S., Marcel Dekker (1998).
3. Semiconductor Lithography: Principles, Practices and Materials, by William Moreau, Plenum Press (1988).
4. Sub-Half Micron Lithography for ULSI, Ed. by Matsui S., Ochiai Y., and Suzuki, K., Cambridge University Press (1999).
5. Nanolithography: A Borderland between STM, EB, IB and X-ray Lithographies, Ed. by Gentili M., Giovannella c., and Se1ci S., NA TO Asi Series E: Applied Sciences, vol. 264, Kluwer Academic Publishers (1994).
6. Solid State Physics, by G.I. Epifanov, Mir Publishers (1979).
7. Semiconductor Devices - Physics and Technology, by S.M. Sze, John Wiley & Sons (2003).
8. Introduction to Semiconductor Devices, by Kevin F. Brennan, Cambridge University Press (2005).
9. The MEMS Handbook, by M.Gad-EI-Hak.
10. Nanoscale Science and Technology, Ed. by Robert Kelsall, lam Hamley and Mark Geoghegan, John Wiley & Sons (2005).
11. Fundamental of Machine Elements, by Hamrock, Jacobson and Schmid.
12. Tribology, Principles and Design Applications, by Amell et al.
13. Tribology Handbook, by B.Bhushan.
14. Principles and Applications ofTribology, by B. Bhushan. Fluid Film Lubrication, by Hamrock

Course Outcomes (COs):

At the end of this course, the student will have

1. The ability to appreciate the current trends in nanotechnology and critical evaluation of the technological potential of inorganic nanostructure materials. [PO2,PO3,PO4,& PO5]
2. Able to understand the physics and chemistry of Nanoscience [PO1,PO2,PO3,PO4,& PO5]
3. Gain knowledge of various fabrication processes and classification techniques for preparing nanostructures. [PO1,PO2,PO4,& PO5]
4. Gain knowledge of various nanoscale characterization tools and their use to characterize nanostructured materials. [PO1,PO2,PO3,PO4,& PO5]
5. To understand Nanotribology and Nano mechanical properties [PO1,PO2,PO3,PO4,& PO5]

MAINTENANCE ENGINEERING AND MANAGEMENT

Course code: MSE E12 **Credits: 4:0:0**
Prerequisite: Nil
Course Coordinator:Dr C M RAMESHA

Preamble

Maintenance is one of the most indispensable jobs in any organization. With the growth of industry and its modernization, new challenges are being faced by maintenance personal in their efforts to minimize the down time and consequently ensure a longer trouble free working life of numerous machinery and equipment. The art of optimizing the available resources of Manpower, materials, tools and equipments with in a set of constraints, to help achieve the goals and objectives of organizations. whether the goals is to produce and sell a product at a profit or is simply to perform a mission in a cost effective manner, the maintenance principles are apply equally to any type of organizations . Maintenance is one of the most essential and important activities in any organization whether it may be product oriented or service oriented sectors. Managerial skill must be incorporated in maintenance design and procedures .to this end the engineering education system has included maintenance engineering as a part of its curriculum. the present topic introduces the basics of maintenance for Postgraduate students of engineering and provides them broad views of maintenance that would assist in taking better managerial decisions wherever a situation demands.

Course learning objective

To provide basic of the maintenance objectives, functions and organization structure of the maintenance department in any organization.

1. To analyze modes of failure of a facility in any organization, application of statistics in failure analysis through some simple models.
2. Students can able to understand concept of maintenance planning and scheduling techniques and optimal inspection frequency.
3. To gain the knowledge of repair cycle, repair complexity and maintenance control indices, individual replacement and group replacement concept to take best replacement decisions.
4. To learn the basic concept of non destructive testing methodology and lubrication program as a part of maintenance activities in a organization and to understand the fundamental concept of CPM and PERT techniques and their application in maintenance projects are to be study.

UNIT I

Objectives and functions of Maintenance, Maintenance Strategies. Organization for maintenance. Characteristics, Benefits, objectives and policies of maintenance, organization and structure of maintenance system: Mechanics of maintenance system. -

Maintenance Systems: Fixed Time Maintenance, Condition based Maintenance, Operate to Failure, opportunity maintenance, Design out maintenance, total productive maintenance

UNIT II

Failure Statistics: Breakdown time distributions, Poisson, Exponential and Normal distribution.

Development of preventive maintenance schedule: Planned prevention of breakdowns – Predictive maintenance - Condition monitoring - Equipment codification and classification - Maintenance budgeting and cost control - Production maintenance integration

UNIT III

Inspection Decision: Optimal Inspection frequency (for maximization of profit and minimization of downtime)

Maintenance Planning scheduling: Planning and scheduling maintenance activities Scheduling techniques

UNIT IV

Replacement Decisions: Optimal interval between preventive replacements of equipment subject to breakdown, group replacement. Repair cycle, Repair complexity and maintenance control indices. Concept of terrotechnology.

Optimal Overhaul, Replacement and Repair: Meaning and Difference, optimal overhaul/Repair / Replace maintenance policy for equipment subject to breakdown**.**

UNIT V

Non-destructive Testing [NDT] in Maintenance Engineering, concept and applications Inspection, Lubrication program development,

Application of CPM and PERT *in* maintenance engineering, Spare parts Management,

REFERENCE BOOKS:

1. Hand book of Maintenance Management _Frank Herbaty-2000
2. Gopala Krishna & A K Banerji “Maintenance and Spare parts Management”
3. Kelly and M.J. Harries “Management of Industrial Maintenance “Butterworth and company Limited.
4. Mishra and Pathak K “Maintenance Engineering and Management “PHI New Delhi-2003
5. Maintenance Engineering. Handbook-Higgins
6. Maintenance planning and control-Anthony Kelly
7. Industrial maintenance -H.P.Garg
8. Plant Engineering Hand book - Stainer
9. Maintainability Principles and Practices by Blanchard, B.S., McGraw Hill, New York -1969.
10. Maintenance Management by Carder, A.S., McGraw Hill, NY, 1976.
11. Joseph D patton “ preventive Maintenance” instrument society of America
12. Srivastava S K “Industrial maintenance and management” PHI New Delhi
13. Ireson & Grant “Hand book of Industrial Engg & management “ PHI New Delhi
14. Siachi Nakajima “A gudi to TPM”

Course Outcomes (COs):

At the end of the course the students are able to:

1. Understand the meaning of maintenance and its importance in any organisation. [PO1,PO2,PO3,PO4,& PO5]
2. Understand and analyse the failure rate and failure parameters and implementation of maintenance methods in shop floor. [PO1,PO2,PO3,PO4, & PO5]
3. Define optimal inspection frequency of a equipment based on maximization of profit and minimization of down time. [PO1,PO2,PO3,PO4,& PO5]
4. Understand the concept of repair cycle, repair complexity and maintenance control indices. [PO1,PO2,PO3,PO4, & PO5]
5. Apply NDT techniques generally used in maintenance activities. [PO1,PO2,PO3,PO4, & PO5]

SURFACE TREATMENT AND FINISHING TECHNIQUES

Subject Code: MSE E13 **Credits: 4:0:0**
Prerequisites: Nil
Course Coordinator: Dr C M RAMESHA

Preamble:
Surface Engineering is a multidisciplinary activity intended to tailor the properties of the surfaces of engineering components so that their function and serviceability can be improved. The ASM handbook defines surface engineering as "treatment of the surface and near-surface regions of a material to allow the surface to perform functions that are distinct from those functions demanded from the bulk of the material". New coatings and treatment processes may create opportunities for new products which could not otherwise exist. It can increase performance, reduce costs and control surface properties independently of the substrate, offering enormous potential. A master's degree course in manufacturing science would be incomplete without the knowledge of such treatment techniques. Hence this course is introduced.

Course Learning Objective:
At the end of this course, the student would be able to understand:

1. Electro plating, diffusion processes and paints
2. Thin films and Thermal spray coatings
3. Characterization and testing of coatings
4. Plasma Surface Engineering of Plastics and High-energy Surface Modifications
5. Heat Treatment of Tool steels, Super alloys, Titanium alloys and Cast iron.

UNIT I

Plating Processes: Fundamentals of Electro deposition, hard chromium plating, Nickel and nickel alloy plating, Electroless nickel plating, and Continious hot dip coatings, Chemical conversion coatings-Phosphate and chromate conversion coatings
Diffusion Processes: Carburizing - Pack carburizing, Gas carburizing, Liquid Carburizing, vacuum carburizing. Nitriding - Gas nitriding, Salt nitriding, Ion nitriding. Carbonitriding, Properties of diffusion coatings.

UNIT II

Thin Film Coatings: Thermal evaporation, Sputter deposition, Ion plating, Pulsed laser deposition, CVD processes and systems, Plasma enhanced CVD, Laser enhanced CVD, Metal organic CVD.
Advanced Thermal spray Coatings: Plasma spray, Detonation gun and High velocity oxy-fuel process, Surface preparation, Equipment and processes, Structure and properties. Uses of thermal spray coating, Bonding mechanisms, Coating materials. Thermal barrier coatings and applications.
Organic coatings: Paints – types, selection, surface preparation and application

UNIT III

Characterization and Testing of Coatings: Film thickness measurements using optical and mechanical techniques; Measurement of coating adhesion-peeling test, Blister test, Scratch test, Tensile type test; Residual stresses in coatings- Measurement using X-ray diffraction, Hole drilling method, Stoneys method; Nano-indentation test to measure hardness, elastic properties, creep and stress relaxation; Thermal properties measurements;

Microstructure characterization- Working principle of Scanning electron microscope, Transmission electron microscope and Optical microscope; Chemical composition analysis-Energy dispersion X-ray analysis, Electron and Ion spectroscopy; Corrosion testing of Coatings-Hot corrosion, Corrosion tests in simulated atmosphere, Salt spray test, Immersion test; Wear and erosion testing of coatings.

UNIT IV

High-energy Surface Modifications: Electron beam surface treatments, Electron beam hardening-Materials and techniques; Laser hardening- Materials and techniques; Laser hard facing; Ion implantation- Equipment, Metallurgical consideration, application.

Fusion Hard Facing Processes: Shielded metal arc welding, Gas tungsten arc welding, Flux cored arc welding, submerged arc welding, plasma arc welding.

Plasma Surface Engineering of Plastics: Plasma processing equipment, Plasma surface modification, Plasma Polymerization. Plasma process applications

UNIT V

Heat Treatment of Tool Steels: Processes and furnace equipments Control of Distortion in tool steels.

Heat Treatment of Superalloys: Introduction, Heat treatment operations, Heat treating solid solution strengthened Iron- Nickel- and Cobalt- base superalloys. Heat Treatment of Titanium and Titanium alloys

Heat Treatment of Cast Iron: Ductile iron-Hardening, Quenching and Tempering, Austempering; Grey iron-Hardening and tempering, Austempering, Martempering, Induction hardening

Defects and Distortion in Heat Treated Parts: Overheating and Burning, Effects of residual stress, Quench cracking; Types of distortion, Methods of preventing distortion.

REFERENCE BOOKS:

1. Surface Engineering for corrosion and wear resistance, J R Davis, ASM International, 2001
2. M. Ohring, The Materials Science of Thin Films, Academic Press Inc, 2005
3. ASM Handbook, Surface Engineering, Vol. 5, ASM Publication, Materials Park, Ohio, 2001.
4. ASM Handbook, Heat Treating, Vol. 4, ASM Publication, Materials Park, Ohio, 2001.

Course Outcomes (COs):

At the end of the course the students are able to:

1. Understand the basics principles involved in surface treatment and finishing techniques[PO1,PO2,PO3,PO4,& PO5]
2. Learn and differentiate various types coatings and its applications. [PO1,PO2,PO3,PO4,& PO5]
3. Gains knowledge about advanced characterization techniques and testing of thin films and coatings. [PO1,PO2,PO3,PO4,& PO5]
4. Understand high-energy Surface Modifications, Hard Facing Processes and Plasma Surface Engineering of Plastics [PO1,PO2,PO3,PO4,& PO5]
5. Ability to apply various heat treatment techniques for super alloys, Tool steels, Titanium alloys and cast iron. [PO1,PO2,PO3,PO4,& PO5]

ADVANCED METAL JOINING PROCESSES

Course code: MSE E14 **Credits: 4:0:0**
Prerequisites: Nil
Course Coordinator : Dr. T ANIL KUMAR

Preamble:
Metal joining is a skill used by many trades: sheet metal workers, iron-workers, marine construction, steamfitters, glaziers, repair and maintenance personnel in applications ranging from the sculpture home hobbies to heavy fabrication of bridges, ships and many other projects. Beginning welders and even those that are more experienced commonly struggle with the problem of weld distortion. Distortion is troublesome for a number of reasons, but one of the most critical is the potential creation of a weld that is not structurally sound. This subject highlights the causes of distortion, effects of shrinkage in various types of welded assemblies and how to control it, and finally look at methods for distortion control. The subject aims in highlighting a variety of welding processes are used to join units of metal and plastics, the basic fundamental methods involved in soldering and brazing. It also highlights the nature of defects formed during welding and means of detecting these defects. Also the subject deals with the mode of communicating the type, location of welds, the principle of design and the costing methodology.

Course Learning Objectives:
At the end of the course, the student will be able to;

1. Define distortion, residual stresses, metal and thermal spraying, understand the concept of distortion during welding process, describe the methods to control distortion, illustrate the stresses developed in welds, predict the causes and effects of distortion, explain the methods of residual stress measurement, metal and thermal spraying techniques.
2. Classify different types of welding processes, learn the concepts, sketch and explain the principle of operation in detail and the electrodes used in welding
3. Learn the different methods of welding dissimilar metals and its metallurgical problems, welding processes for plastics, Various types of soldering and brazing processes
4. Outline the stages of inspection, Judge the type of defects that could be traced using various techniques adopted in inspection of welds
5. Write the symbols used in welding, understand the principles of welding design, welding positions, welding cost estimation

UNIT I

Distortion, Types of distortion and methods to control distortion. Residual stresses in welds, definition, concept types causes and effects, Residual stress measurement. Metal spraying, classification of thermal spraying process equipments,

UNIT II

Electro slag, welding electron beam welding, Plasma arc welding, Laser beam welding, Explosion welding, Diffusion welding, Ultrasonic welding, Friction welding and Thermit welding. , concepts, principle of operation, equipments, advantages, disadvantages and applications of the above processes, welding electrodes -Types, selection of electrodes. Applications of coated electrodes. Introduction to automatic welding: robotic welding, underwater welding.

UNIT III

Welding of dissimilar metals, concepts, metallurgical problems, Plastic welding processes, fusion welding processes, advantages and disadvantages of each processes advanced soldering and Brazing processes, different types of soldering and brazing processes

UNIT IV

Inspection of Welds: Stages, Destructive techniques like tensile, bend, and Nick break, Impact & Hardness tests. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection. Weld quality, factors to be considered, Discontinuities in welds, their causes and remedies ,Quality conflicts

UNIT V

Welding Symbols- Need for representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples. Welding cost estimation, main components, factors, basic costing procedure. Brief introduction to Software's for welding engineers: MAGDATA, PREHEAT, WELDCOST, WELDSPEC, WELDVOL, SUPERWELDBEST.

REFERENCE BOOKS:

1. Welding Engineering Hand Book by AWS.
2. Welding Engineering by Rossi
3. Advanced Welding Processes-Nikolacv .G.O.L Shansky MIR Publications.1997
4. Welding Technology by O.P.Khanna.
5. Welding for engines by Udin, Funk & Wulf
6. Welding and welding technology-R.L.Little

Course Outcomes (COs):

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

1. Define distortion, residual stresses, metal and thermal spraying, understand the concept of distortion during welding process, describe the methods to control distortion, illustrate the stresses developed in welds, predict the causes and effects of distortion, explain the methods of residual stress measurement, metal and thermal spraying techniques. [PO1,PO2,PO3,PO4, & PO5]
2. Classify different types of welding processes, learn the concepts, sketch and explain the principle of operation in detail and the electrodes used in welding. [PO1,PO2,PO3,PO4,& PO5]
3. Learn the different methods of welding dissimilar metals and its metallurgical problems, welding processes for plastics, Various types of soldering and brazing processes. [PO1,PO2,PO3,PO4,& PO5]
4. Outline the stages of inspection, Judge the type of defects that could be traced using various techniques adopted in inspection of welds. [PO1,PO2,PO3,PO4,& PO5]
5. Write the symbols used in welding, understand the principles of welding design, welding positions, welding cost estimation. [PO1,PO2,PO3,PO4,& PO5]

PRODUCT DATA MANAGEMENT

Sub Code: MSE E15 **Credits: 4:0:0**
Prerequisites: Nil
Course Coordinator:Dr. SRIDHAR B S

Preamble:

With changes in technology different methods of storing data pertaining to the manufacturing field have evolved. There are continuous studies on improvement of the product life by using various techniques. There are some standard methods of preparing the data and storing the same. And also there is a need to improve the methods of manufacturing. This course deals with the study of such advanced manufacturing to serve the required purpose.

Course Learning Objectives:

1. The course provides an opportunity to know the concept of the subject Products Data and its managing ability, life cycle of the product, methods of manufacturing etc.
2. The students will have the knowledge to study the life cycle of the product and its management
3. The students learn to analyze different processes/ terminologies of the change management and its applications
4. The students learn to describe the structure of management and its configuration.
5. The students will have the knowledge to improve different methods of management, such as the concept of agility, enterprise integration, etc. and the overview of different resources for creating data

UNIT I

Introduction: PDM-present market constraints, the need for collaboration- Internet and developments in server-client computing, Components of a typical PDM, set-up hardware and software, document management, creation and viewing of documents, creating parts-version, control of parts and documents, case studies.

UNIT II

Configuration Management: Software configuration management, Computer hardware configuration management, Maintenance systems, Configuration Management and Engineering Change Control, Configuration Control, Baselines-product structure, configuration management, case studies.

UNIT III

Product Life Cycle :Life cycle of a product- life cycle management, automating information flow - work flows, Creation of workflow templates, life cycle, workflow integration, case studies.

UNIT IV

Change Management: Change Management(An It Perspective) change issue, change request, investigation, change proposal-change activity, Borland Change Management Solutions, Change Management System, Case Studies.

UNIT V

Database And Database Users: Introduction, Building blocks, Database design, ER Diagram (Entity-relationship model) advantages and implementation of database approach

Agile Supply Chains Management: Introduction, characteristics of Agile Manufacturing Concept of Agile Manufacturing Strategy of Agile Manufacturing, Methodology Of Marketing, Key Issues in Agile Manufacturing, Future Of Agile Manufacturing

TEXT BOOKS:

1. David Bed worth. Mark Henderson &. Philips Wolfe, "Computer Integrated Design and Manufacturing"', McGraw Hill Inc., 1991.
2. Product Design and Manufacturing, A.C.Chitale and R.C. Gupta, PHI 4th edition 2007.
3. **'Agile Manufacturing**- Forging Mew Frontiers', **Poul T Kidd,** Amagow Co. UK, ISBN-0-201- 63163-6, 1994
4. **Fundamentals of Database Systems,** Ramez Elmasri and Shanmkanth B. Navathe, 3rd Edition, Addison Pearson.

REFERENCE BOOKS:

1. Terry Quatrain "Visual Modeling with Rational Rose and UML ", Addison Wesley, 1998
2. Wind-chill RS.O Reference manuals. 2000.

Course Outcomes(COs):

1. The students can express the concept of the subject Products Data and its managing ability, Life cycle of the product, methods of manufacturing etc. [PO1,PO2,PO4,& PO5]
2. The students are capable of defining the life cycle of the product and its management[PO1,PO2,PO3,PO4,& PO5]
3. The students are capable to understand the methods/ processes involved in the change management. [PO1,PO2,PO4,& PO5]
4. The students are aware of configuration management and the structure of management. [PO1,PO3,PO4,& PO5]
5. The students are capable to compile about the different methods of management. The students are in a position to evaluate the different methods of data storing and its management. [PO1,PO2,PO4, & PO5]

INDUSTRIAL ROBOTICS

Course Code : MSE E16 **Credits: 4:0:0**
Prerequisites : Nil
Course Coordinator: Dr. SUNITH BABU L

Preamble
This course provides an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, exposure is given to 3D graphic simulation; control design, actuators, and sensors; wireless networking, task modeling, human-machine interface, and embedded software.
Students are exposed to the concept of DH Methods, transformation matrices. A wide scope is give to the area of Applications where in students understand as to how robotics can be applied in area of welding machine loading and unloading, die casting, forging, spray painting and drilling. Various leg configuration followed by programming sequence, planning, path planning, obstacle avoidance is discussed.

Course Learning Objectives:

1. To acquire the knowledge of robotic technology and provide solutions to implement robotics systems quickly and effectively.
2. To develop skill-set in transformation and DH sequence analysis.
3. Develop an ability in analyzing the possible application of robots in different fields of engineering.
4. Develop skill sets in analyzing the type of leg configuration system in different application.
5. Enable real – time programming and obstacle avoidance system

UNIT I

Basic Concepts of Robotics: Introduction, Definition, Classification, History, Components, DoF, Accuracy, Repeatability, Precision, Joints, Coordinates, Reference Frames, Robot Motions, Joint Notation Schemes, Workspace, Characteristics, Robot Terminologies, Robot System Integration process for Industrial Robot.

UNIT II

Physical configurations: Work volumes of an Industrial robot the wrist and its motions, Grippers and types, Robot Motion and Analysis. Kinematic Analysis and Coordinate

Transformations: Direct kinematics problem in Robotics, Euler's angle representation, Basic transformations, Rotation about an arbitrary axis, Homogeneous transformation matrices, Denvit and Hertanberg Convention, Applications of D-H Method- Six Axis Robot Manipulators

UNIT III

Industrial Application of Robotics: Robots in Industry – Pick and Place, Spray Coating, Assembly, Inspection. Robots in Handling – Machine Loading and Unloading, Material Transfer, Palletizing, Welding, Robot Compliance, Assembly Applications, Applications of Cobots, Applications in Construction

Medical Applications: Da Vinci Surgical Robots, Rehabilitation Robot, Bio Robots, Telepresence Robots.

Autonomous Mobile Robots: Introduction, Locomotion-key issues for locomotion, Legged Mobile Robots

UNIT IV

Leg configurations and stability: Wheeled Mobile Robots, Difference between wheeled and legged mobile Robots, Mobile Robot Kinematics: Introduction, Kinematics Models and Constraints, Representing robot position, Forward kinematics models, Wheel kinematics constraints, Robot kinematics constraints.

Mobile Robot Maneuverability: Degree of Mobility, Degree of Steerability, Robot maneuverability.

UNIT V

Mobile Robot Planning and Navigation: Introduction, Competences for Navigation Planning and Reacting, Path Planning, Obstacle avoidance, Navigation architectures-Modularity – Modularity code reuse and sharing, Control localization, Techniques for decomposition.

Programming Languages: Introduction, Levels of Programming Languages, and Introduction to VAL, RAIL and AML languages. Example of programming by VAL II.

TEXT BOOKS:

1. M P Groover "Industrial Robotics" MGH.
2. Yoren and Koren, "Robotics for Engineers" MGH
3. Robotics and Manufacturing Automation, by C Ray Asfahl, John Wiley and Sons, Inc, Second edition.
4. Introduction to Autonomous Mobile Robots – Roland, Illah, MIT Press, ISBN – 0-262-19502 – x
5. Saeed B. Niku, "Introduction to Robotics analysis, Systems & Applications", Pearson Education Singapore P. Ltd., 2002.

REFERENCE BOOKS:

1. Robotics by Fu and Lee, Tata McGraw-Hill Education, 1987
2. Walking machines- An introduction to Legged Robots by D J Todd.

Course Outcome (COs):

1. To ascertain the acquired knowledge and develop robotic solutions to meet the industry demands. [PO1, PO2, PO3, PO4 & PO5]
2. Demonstrate the ability to apply the spatial transformation and obtain forward kinematics equation and DH workflow. [PO1, PO2, PO3, PO4 & PO5]
3. Be proficient in quickly analyzing the possible application of robots in potential areas of engineering domain. [PO1, PO2, PO3, PO4 & PO5]
4. Formulate the potential workflow to ensure quick maneuverability of robot systems. [PO1, PO2, PO3, PO4 & PO5]
5. Validate the predicted navigation system and develop appropriate programming sequence. [PO1, PO2, PO3, PO4 & PO5]

CNC SYSTEMS AND PROGRAMMING

Subject Code: MSE E17 **Credits: 4:0:0**
Prerequisites: Nil
Course Coordinator:Dr K LOKESHA

Preamble:
The declining cost of microcomputers change the look of factory floor. Modern manufacturing systems and industrial robots are advanced automation systems that utilize computers as an integral part of their control. Computers are vital part of automation. There is increase in case of computer controlled machine tools in the production line. Numerical controlled (NC) machine tools are more accurate than conventional machine tools, which can reduce all non-automating machining time, apply fast tool changing method and idle motions by increasing the rapid traverse velocities. Numerical controlled (NC) machines and Computer Numerical controlled (CNC) machines employ control circuits, which include counters, decoders, DAC converters etc.,. Computer Control of Manufacturing Systems employs closed loop controllers that measure state of system during operation and decrease effects of load disturbances and compensate in real time for parameter variation. To improve production rate or reduce machining cost adaptive control is used to automatically set the optimal operating parameters subject to machining constraints in order to optimize the performance of overall system. The supervision of flexible manufacturing system is performed by computer integrated manufacturing (CIM) systems in which production flow from the conceptual design through the finished products will be entirely under computer control and management.

Course Learning Objectives:

1. To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system.
2. To create awareness in CNC system design and CNC construction features.
3. To make the students to understand the basic concepts of hardware and software component of CNC system.
4. To make the students to develop the CNC part program for turning and milling operations.
5. To impart the concepts of CNC systems in non-traditional machining process and the role of adaptive control systems in CNC systems.

UNIT I

Introduction: Introduction to CAD/CAM integration, CAM and its historical development, Fundamentals of numerical control, classification of N.C systems, CNC concepts, the digital computer, reference pulse technique, sample data technique, microprocessor in CNC systems. Advantages and limitations of CNC systems. DNC concepts. Factors to be considered for selecting machine tool.

Features of CNC Machine tools: Design consideration of CNC machine tools, guide ways, Friction, Anti friction and other types of guide ways. Elements used to convert the rotary motion to a linear motion Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, and spindle assembly. Torque transmission elements, gears, timing belts, flexible couplings, Bearings, Spindle drives and feed drives

UNIT II

Increasing productivity with CNC machines: CNC Machine tool and machining centre, Cutting tool materials, HSS, Carbides, Ceramics, CBN, PCD, cutting tool inserts, qualified, semi qualified and preset tooling. Tool holding systems for CNC machining centers, automatic tool changers. Work holding devices for CNC machining centers, vices, pallets, indexing devices, automatic pallet changer, robots for loading jobs & material handling, hydraulic and pneumatic Fixtures, anti-vibration boring bars. Shrink Fit Adaptors for Drills and Reamers. Automatic swarf removal system.

System devices: Drives – Hydraulic system, Stepper motor, Servo motor, DC and AC motors, Feedback devices – Encoders, Resolvers, Inductosyn, Counting devices – Flip-Flops, Counters, decoder, Digital to Analog converters – Weighted resistor network, resistor ladder network. Interpolators – DDA integrator, DD hardware interpolator, CNC software interpolator, reference word CNC interpolator.

UNIT III

CNC part programming for turning: Introduction, selection of cutting tool, work holding device, process parameters. Tool offset, work offset, machine reference, tool path, Coordinate system, G and M codes, CNC part program including – facing, turning, countering, drilling, grooving, thread cutting, tapping, reaming, boring. Introduction to commercial CNC part programming software and CAD compatibility, basic steps followed to generate CNC program from a CAD file.

UNIT IV

CNC part programming for milling: Introduction, selection of cutting tool, work holding device, process parameters. Tool offset, work offset, machine reference, tool path, Coordinate system, G and M codes, CNC part program including – facing, pocket milling, countering, drilling, boring, reaming, thread cutting, tapping, sub program. Introduction to commercial CNC part programming software and CAD compatibility. Introduction to APT programming – geometric and motion statements

UNIT V

Control loop systems: Introduction, control of point to point System, control of contouring systems.

Adaptive control systems: Introduction, adaptive control with optimization Adaptive control with constraints, variable gains AC systems, adaptive control of grinding, cost analysis in machining.

CNC concepts: DNC Systems, Machining Cell, Flexible manufacturing systems, introduction to the CNC concepts in non-traditional machining process.

TEXT BOOKS:

1. Martin J. Numerical control of machine tools
2. Yoram .Koren "Computer Controls of Manufacturing Systems" McGrawHill 1983
3. James V. Valentino and Joseph Goldenberg, Introduction to Computer Numerical Control, 5th Edition, Prentice Hall, Engle wood Cliff, New Jersey, 2012.
4. David Gibbs and Thomas Crandall, CNC Machining and Programming: An Introduction, Industrial Press Inc., 2003.

REFERENCE BOOKS:

1. Y.koren & J.Benuri "Numerical control of machine tools", Khanna Pub 2005.
2. Wilson F.M "Numerical control in manufacturing" McGraw Hill Newyor.
3. Robot Technology Fundamental by James. G. Keramas, Denmark Pub 1985.

4. Chang, T. C., Wysk, R.A. and Wang, H.P., “Computer Aided Manufacturing”, Pearson Prentice Hall, 2009.
5. Jones, B.L., “Introduction to Computer Numerical Control”, Pitman, London, 1987.
6. “Mechatronics”, HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.

Course Outcomes (COs):

Student will be able to

1. Understand the fundamental concepts, design and features of CNC systems. [PO1, PO2, PO3, PO4 & PO5]
2. Understand the basic concepts of adaptive control systems in CNC systems. [PO1, PO2, PO3, PO4 & PO5]
3. Analyze CNC machining process and process parameters (feed, speed, depth of cut, cutting tools, work holding devices, etc.) for the given product. [PO1, PO2, PO3, PO4 & PO5]
4. Evaluate for optimal process. [PO1, PO2, PO3, PO4 & PO5]
5. Create the CNC part program involving turning and milling operations. [PO1, PO2, PO3, PO4 & PO5]