ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MANUFACTURING ENGINEERING

M.E. Manufacturing Engineering (Two Year) Degree Programme

Choice Based Credit System

(Full - Time)

HAND BOOK

2017

DEPARTMENT OF MANUFACTURING ENGINEERING

VISION

To prepare students to be life-long learners and global citizens with successful careers in design, research, development, and management of systems in manufacturing and service organizations

MISSION

- A curriculum and educational experience designed and continuously improved through involvement and contribution of students, faculty, administrators, staff, and industry
- A well-focused research program funded at the local, regional, and national level
- A demonstrated competence and expertise in addressing the needs of industry and community at large

M.E. Manufacturing Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. The graduates acquire ability to create model, design, synthesize and analyze essential production operational skills, mechanism and automation system.
2. The graduates use their talent, self-confidence, knowledge and engineering practice which facilitate them to presume position of scientific and/or managerial leadership in their career paths.
3. The graduates apply their consciousness of moral, professional responsibilities and motivation to practice life-long learning in a team work environment.

PROGRAM OUTCOMES (PO)

Upon Completion of the two years of the Master of Manufacturing Engineering Degree,

PO1: INTEGRATION OF KNOWLEDGE

Acquire and apply fundamental knowledge and understanding of Science and Technology of Production and Industrial Engineering.

PO2: PROBLEM ANALYSIS

Acquire abilities and capabilities to solve problems in the areas of advanced manufacturing methods, quality assurance and shop floor management.

PO3: DESIGN AND DEVELOPMENT OF SOLUTIONS

Demonstrate the ability to improve a production process or system that meets desired specifications and requirements by following professional and intellectual integrity, professional code of conduct, ethics on professional practices, understanding responsibilities and norms for sustainable development of society.

PO4: USE OF MODERN TOOLS AND TECHNIQUES

Formulate relevant research problems; conduct experimental and/or analytical work and analyzing results using modern mathematical and scientific methods.

PO5: COLLABORATIVE AND MULTIDISCIPLINARY APPROACH

Design and validate technological solutions to defined problems and write clearly and effectively for the practical utilization of their work by interacting with the engineering community and with society at large, regarding intricate engineering activities on technical perspectives and emerge as an efficient motivator.

Mapping of PO with PEO					
PEOs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
PEO1	✓	✓	✓	✓	
PEO2	✓		✓		✓
PEO3			✓		✓

M.E. Manufacturing Engineering (Two Year) Degree Programme
Choice Based Credit System (CBCS)

REGULATIONS

1. **Condition for Admission**
   Candidates for admission to the first year of the four-semester **M.E / M.Tech Degree programme in Engineering** shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part time programme is restricted to those working or residing within a radius of **90 km** from Annamalainagar. The application should be sent through their employers.
2. **Branches of Study in M.E / M.Tech**
   The Branch and Eligibility criteria of programmes are given in **Annexure 1**
3. **Courses of study**
   The courses of study and the respective syllabi for each of the M.E / M. Tech programmes offered by the different Departments of study are given separately.
4. **Scheme of Examinations**
   The scheme of Examinations is given separately.
5. **Choice Based Credit System (CBCS)**
   The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.
6. **Assignment of Credits for Courses**
   Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.
7. **Duration of the programme**
   A student of **M.E / M.Tech** programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.
8. **Registration for courses**
   A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.
9. **Electives**
   The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/

allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First assessment (Test-I)	:	15 marks
Second assessment (Test-II)	:	15 marks
Maintenance of record book	:	10 marks
End Semester Examination	:	60 marks

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester, monitor their progress in SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee

For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.

- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet **three** times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study

A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of **four years for Full time / six years for Part time.**

14. Substitute Assessments

A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. Attendance Requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. Passing and declaration of Examination Results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

90 to 100 marks	Grade 'S'
80 to 89 marks	Grade 'A'
70 to 79 marks	Grade 'B'
60 to 69 marks	Grade 'C'
55 to 59 marks	Grade 'D'
50 to 54 marks	Grade 'E'
Less than 50 marks	Grade 'RA'
Withdrawn from the Examination	Grade 'W'

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.\

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking Of Candidates

The candidates who are eligible to get the M.E /M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. Transitory Regulations

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

ANNEXURE - 1

S.No.	Department		Programme (Full Time & Part time)	Eligible B.E./B.Tech Programme *
1	**Civil Engineering**	i.	Environmental Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Industrial Engg, Chemical Engg, BioChemical Engg, Biotechnology, Industrial Biotechnology, Chemical and Environmental Engg.
		ii.	Environmental Engineering & Management	
		iii.	Water Resources Engineering & Management	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Agricutural anf irrigation Engg, Geo informatics, Energy and Environmental Engg.
2	**Civil & Structural Engineering**	i.	Structural Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg.
		ii.	Construction Engg. and Management	
		iii.	Geotechnical Engineering	
		iv.	Disaster Management & Engg.	
3	**Mechanical Engineering**	i.	Thermal Power	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical Engg (Manufacturing).
		ii.	Energy Engineering & Management	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical (Manufacturing) Engg, Chemical Engg
4	**Manufacturing Engineering**	i.	Manufacturing Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Mechatronics Engg, Industrial Engg.
		ii.	Welding Engineering	
		iii.	Nano Materials and Surface Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Chemical Engg
5	**Electrical Engineering**	i.	Embedded Systems	B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Information technology, Electronics and communication Engg, Computer Science and Engg
		ii.	Smart Energy Systems	B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg,
		iii.	Power System	
		i.	Process Control & Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical

6	**Electronics & Instrumentation Engineering**			and Electornics Engg, Control and Instrumentation Engg, Instrumentation Engg
		ii.	Rehabilitative Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics.
		iii.	Micro Electronics and MEMS	B.E. / B.Tech – B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics, Telecommunication Engg
7	**Chemical Engineering**	i.	Chemical Engineering	B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology
		ii.	Food Processing Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Biochemical Engg, Agricultural Engg.
		iii.	Industrial Bio Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology
		iv.	Industrial Safety Engineering	B.E. / B.Tech – Any Branch of Engineering
8	**Computer Science & Engineering**	i.	Computer Science & Engineering	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
9	**Information Technology**	i	Information Technology	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
10	**Electronics & Communication Engineering**	i.	Communication Systems	B.E. / B.Tech - Electronics and Communication Engg, Electronics Engg.

*** AMIE in the relevant discipline is considered equivalent to B.E**

M.E. Manufacturing Engineering (Two Year) Degree Programme

Choice Based Credit System (CBCS)

Subjects of Study and Scheme of Examinations

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – I										
1	PC-I	MFEC101	Applied Probability & Statistical Inferences	4		-	25	75	100	3
2	PC-II	MFEC102	Mechanical Behaviour of Materials	4		-	25	75	100	3
3	PC-III	MFEC103	Metal Forming Technology	4		-	25	75	100	3
4	PC-IV	MFEC104	Mechanics of Metal Machining	4		-	25	75	100	3
5	PE-I	MFEE105	Professional Elective I	4		-	25	75	100	3
6	PE-II	MFEE106	Professional Elective II	4		-	25	75	100	3
7	PC Lab-I	MFEP107	Production Engineering Lab-I	-	-	3	40	60	100	2
			Total	**24**	**-**	**3**	**190**	**510**	**700**	**20**

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – II										
1	PC-V	MFEC201	Manufacturing Management	4	-	-	25	75	100	3
2	PC-VI	MFEC202	Metal Joining Technology	4	-	-	25	75	100	3
3	PC-VII	MFEC203	Metal Casting Technology	4	-	-	25	75	100	3
4	PC-VIII	MFEC204	Machine Tool Drives and Controls	4	-	-	25	75	100	3
5	PE-III	MFEE205	Professional Elective III	4	-	-	25	75	100	3
6	PE-IV	MFEE206	Professional Elective IV	4	-	-	25	75	100	3
7	PC Lab-II	MFEP207	Production Engineering Lab-II	-	-	3	40	60	100	2
8	Seminar	MFES208	Seminar		-	2	100	-	100	1
			Total	**24**	**-**	**5**	**290**	**510**	**800**	**21**

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – III										
1	OE-I	MFEE301	Open Elective – I	4	-	-	25	75	100	3
2	OE-II	MFEE302	Open Elective – II	4	-	-	25	75	100	3
3	Thesis	MFET303	Thesis Phase-I	-	4	-	40	60	100	4
4	Ind Train	MFEI304	Industrial Training *		*	-	100	-	100	2
			Total	**8**	**4**	**-**	**190**	**210**	**400**	**12**

Note: * - Four weeks during the summer vacation at the end of II Semester.

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – IV										
1	Thesis	MFET401	Thesis Phase-II	-	8	-	40	60	100	12
			Total	**-**	**8**	**-**	**40**	**60**	**100**	**12**

L- Lecture ; **P-** Practical; **T-** Thesis; **CA-** Continuous Assessment; **FE-** Final Examination

M.E. Manufacturing Engineering (Part Time) Degree Programme
Choice Based Credit System (CBCS)

Subjects of Study and Scheme of Examinations

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – I											
1	PC-I	PMFEC 101	Applied Probability & Statistical Inferences	4	-	-	25	75	100	3	MFEC101
2	PC-II	PMFEC 102	Mechanical Behaviour of Materials	4	-	-	25	75	100	3	MFEC102
3	PC-III	PMFEC 103	Metal Forming Technology	4	-	-	25	75	100	3	MFEC103
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – II											
1	PC-IV	PMFEC 201	Manufacturing Management	4	-	-	25	75	100	3	MFEC201
2	PC-V	PMFEC 202	Metal Joining Technology	4	-	-	25	75	100	3	MFEC202
3	PC-VI	PMFEC 203	Metal Casting Technology	4	-	-	25	75	100	3	MFEC203
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – III											
1	PC-VII	PMFEC 301	Mechanics of Metal Machining	4	-	-	25	75	100	3	MFEC104
2	PE-I	PMFEE 302	Elective I	4	-	-	25	75	100	3	MFEE105
3	PE-II	PMFEE 303	Elective II	4	-	-	25	75	100	3	MFEE106
4	PC Lab-I	PMFEP 304	Production Engineering Laboratory - I	-	3	-	40	60	100	2	MFEP107
			Total	**12**	**3**	**-**	**115**	**285**	**400**	**11**	

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
Semester – IV											
1	PC-VIII	PMFEC 401	Machine Tool Drives and Control	4	-	-	25	75	100	3	MFEC204
2	PE-III	PMFEE 402	Elective III	4	-	-	25	75	100	3	MFEE205
3	PE-IV	PMFEE 403	Elective IV	4	-	-	25	75	100	3	MFEE206
4	PC Lab-II	PMFEP 404	Production Engineering Laboratory-II	-	3	-	40	60	100	2	MFEP207
	Seminar	PMFES 405	Seminar		-	2	100		100	1	MFES208
			Total	**12**	**3**	**-**	**115**	**285**	**400**	**11**	

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
Semester – V											
1	OE-I	PMFEE 501	Open Elective I	4	-	-	25	75	100	3	MFEE301
2	OE-II	PMFEE 502	Open Elective II	4	-	-	25	75	100	3	MFEE302
3	Thesis	PMFET 503	Thesis Phase I	-	-	4	40	60	100	6	MFET303
4	Industrial Training	PMFEI 504	Industrial Training		*	-	100		100	2	MFEI304
			Total	**8**	**-**	**4**	**90**	**210**	**300**	**12**	

Note: * - Four weeks during the summer vacation at the end of IVth Semester.

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
		Semester – VI									
1	Thesis	PMFET 601	Thesis-Phase II and Viva Voce	-	-	8	40	60	100	13	MFET401
			Total	**-**	**-**	**8**	**40**	**60**	**100**	**13**	

L- Lecture ; **P-** Practical; **T-** Thesis; **CA-** Continuous Assessment; **FE-** Final Examination

LIST OF PROFESSIONAL ELECTIVES

1 Maintenance Management
2 Computer Integrated Manufacturing Systems
3 Plant Layout and Material Handling
4 Composite Materials
5 Tool Engineering
6 Automats and Transfer Machines
7 Design for Manufacturing and Assembly
8 Impact Engineering
9 Precision Engineering and Nano-Technology
10 Nano Materials Technology

LIST OF OPEN ELECTIVES

1 Engineering Economics
2 Total Quality Management
3 Supply Chain Management

MFEC101	APPLIED PROBABILITY & STATISTICAL INFERENCES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To introduce the basic concepts of one dimensional and two dimensional Random Variables.
- To introduce probability theory and statistics from a computational perspective
- To enable the students to use the concepts of Testing of hypothesis, regression, correlation & Design of experiment
- To understand the role and importance of non parametric test in manufacturing

No derivation, only application in problem solving

Introduction to Probability Theory: Classical, empirical and subjective probabilities. Introduction to Statistics and Data – Types of Data - Quantitative Data, Qualitative Data, Logical Data, Multivariate Data etc. - nominal, ordinal, interval and ratio data. Features of Data distributions - Center, Spread, Shape, Symmetry, Skewness and Kurtosis (Definitions only), Frequency Distributions and Histogram, Stem and Leaf Diagrams, Measures of Center - Mean, Median, Mode, Measures of Spread - Range, Variance, Standard Deviation, Measures of Relative Position: Quartiles, Percentiles, Inter quartile range.

Distribution and functions: Random Variables, Discrete Random Variables, Probability Distributions and Probability Mass Functions, Mean and Variance of a Discrete Random Variable, Discrete Uniform Distribution - Mean and Variance, Binomial Distribution - Mean and Variance, Poisson Distribution - Mean and Variance.
Continuous Random Variables, Probability Distributions and Probability Density Functions, Mean and Variance of a Continuous Random Variable, Continuous Uniform Distribution, Mean and Variance, Normal Distribution, Mean and Variance (Proof not required).

Inference: Statistical Inference, Types of sampling and sampling error, Random Sample & Statistic, Sampling Distribution, Central Limit Theorem (Statement Only), Distribution of sample mean and sample variance, t, chi-square and F distributions (derivation not required), Confidence Interval on the Mean, Confidence Interval on the Variance, Confidence Interval for a Population Proportion, Confidence Interval on the Difference in Means, Confidence Interval on the Ratio of two Variances.

Testing of Hypothesis & Non Parametric Test: Introduces hypothesis testing methodology, one and two sample z and t tests, Type I and Type II errors - testing of mean, difference in mean and proportions – Tests for Independence of attributes , Goodness of fit and simple linear regression and correlation. Non parametric test: run test, sign test, U test & H test.

Design of Experiment: Experimental design – Analysis of variance – Methods for one, two factor models, completely randomized blocks - concepts of factorial design, fractional factorial design, response surface methods and central composite design.

REFERENCES:

1. Jay L. Devore, "Probability and Statistics For Engineering and the Sciences", Thomson and Duxbury, 2002.
2. Mario F. Triola. Elementary Statistics, Ninth Edition. Boston: Pearson Education, Inc., 2004. Johanna
3. Richard Levin. I., "Statistics for Management", PHI, 1988.
4. Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers", Wiley India, 5th Edition (2012).
5. David S. Moore and George P. McCabe, "Introduction to practice of statistics", W.H. Freeman & Company, 5th Edition (2005).
6. Richard A .Johnson, Miller and Freunds, "Probability and Statistics for Engineers", Prentice Hall of India, 8th Edition (2015).
7. Gupta S.C and Kapoor V .K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons (2014).
8. Mendenhall, Beaver, Beaver, Introduction to Probability & Statistics, Cengage Learning, 14th Edition (2014)

COURSE OUTCOMES:

1. Acquire basic knowledge in statistics
2. The student will able to acquire the basic concepts of Probability and Statistical techniques for solving real life problems and Engineering problems.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2		✓	✓	✓	✓

MFEC102	**MECHANICAL BEHAVIOUR OF MATERIALS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To impart a sound understanding of the tensile, hardness and toughness behaviour of materials.
- To understand the factors affecting the fatigue and fracture behaviour of materials.
- To study the time dependant mechanical behaviour of materials.

Tensile behaviour: Engineering stress-strain curve: Derivation of tensile strength, yield strength, ductility, modulus of elasticity, resilience and toughness from stress strain curves, comparison of stress-strain curves for different materials - True Stress - Strain Curve: true stress at maximum load, true fracture strain, true uniform strain, Necking strain - necking Criteria - Effect of strain rate, temperature and testing machine on flow properties - Notch tensile test - Tensile properties of steel - strengthening mechanisms - Strain hardening - Strain aging - Yield point phenomena - Solid solution strengthening - Martensite Strengthening - Grain refinement, Hall-Petch relation**.**

Hardness & Toughness behaviour: Hardness Measurements: Brinnell hardness, Meyer's hardness, Vickers hardness, Rockwell hardness and Microhardness - Relationship between

hardness and the flow curve - Hardness at elevated temperatures - Toughness measurements: Charpy, Izod and Instrumented Charpy - Transition Temprature Curves: significance, various criteria, metallurgical factors affecting the curves, Drop weight test, explosion crack starter test, Dynamic tear test and Robertson crack arrest test - Fracture Analysis Diagram.

Fatigue behaviour: Introduction: Stress cycles, S-N curves Goodman diagram, Soderberg diagram, Gerbar diagram - Cyclics stress strain curve - Low cyle fatigue - Strain life Equation - Fatigue mechanisms - High cycle fatigue - Effect of following paramenters on Fatigue: mean stress, stress concentration, specimen size, surface roughness, residual stress, microstructure and temperature. Fatigue crack propagation - Fatigue under combined stresses - Cumulative fatigue damage - Design for fatigue.

Fracture behaviour: Types of fracture in metals: ductile and brittle fracture - Theoretical cohesive strength of metals - Griffith theory - Metallographic aspects of fracture - Fractography - Notch effect - Concept of fracture curve - Fracture under Combined Stresses - Environment sensitive fracture: hydrogen embrittlement, stress corrosion cracking - Fracture mechanics: strain energy release rate, stress intensity factor, crack deformation modes, fracture toughness testing, plastic zone size correction, crack opening displacement, J-integral and R-curve.

Time dependant mechanical behaviour: Creep curve - Stress rupture Test - Structural changes during creep - Mechanisms of creep deformation - Deformation mechanisms maps - Activation energy for steady state creep - Fracture at elevated temperature - Introduction to high temperature alloys - Predication of long time properties - Creep under combined stresses - Creep- Fatigue Interaction.

REFERENCES:

1. George E.Dieter, Mechanical Metallurgy, Tata McGraw – Hill Education Pvt.Ltd, 3rd Edition. New Delhi, 2014.
2. Hertzberg R.W., Richard W. Hertzberg , Richard P. Vinci , Jason L. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, Inc., 5th Revised Edition, New York, 2012.
3. Thomas Courtney. H, Mechanical Behavoiur of Materials, McGraw Hill 2nd Edition, 2005.
4. M.A.Meyers and K K.Chawla, Mechanical Behavior of Materials, Cambridge University Press, 2009
5. H. Kuhn and D. Medlin , Metals Handbook, Mechanical Testing, Vol.8, American Society for Metals, Metals Park, Ohio, 2000
6. Broek.D, Elementary Engineering Fracture Mechanics, 4th Edition.,Martinus Nijhoff Publishing , The Hague, 2008

COURSE OUTCOMES:

1. Understand the mechanical behaviour of metals;
2. Protect the metals from fatigue damage.
3. Understand the environmental factors affecting the mechanical behaviour of materials
4. Evaluate the high temperature properties of metals.
5. Design the metals for specific applications;

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2		✓			
CO3					✓
CO4		✓	✓		
CO5					✓

MFEC103	**METAL FORMING TECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To familiarize response of materials under plastic deformation
- To Predict the stress for various metal working processes
- To Determine the working load for various forming process
- To familiarize the slip line field theory and upper bound analysis
- To introduce Recent developments in high speed forming

Description of stress at a point-state of stress in two dimensions and three dimensions-stress tensor –Mohr's circles- two dimensions and three dimensions state of stress. Hydrostatic and stress deviator. Fundamentals of plasticity-flow curve-true stress and true strain-yielding criteria for ductile loads combined stress test-octahedral shear stress and shear strain-invariants of stress and strain-plastic stress and strain relations-Levy-mises equation-Prandtl-Resus equations.

Determination of workload-work formula for homogenous deformation-rolling, rod drawing and extrusion processes. Determination of load by stress evaluation method: Determination of drawing load-strip drawing with wedge shaped dies , cylindrical rod drawing with a conical die , tube drawing and tube sinking. Determination of roll load and roll force.

Determination of load by stress evaluation method: Determination of forging load-plane strain forging of a thin strip and a flat circular disc. Determination of extrusion load for round bar and flat strip. Slip line field theory - Plane strain indentation of punch and Plane strain extrusion process. Upper bound analysis – Plane strain indentation with frictionless interface and Plain strain frictionless extrusion

Effect of high speed on stress strain relationships - effect of friction, temperature and stress waves-comparison and requirements of HVF equipments. Description of high speed forming machine-hot forging, pneumatic - mechanical, high velocity forging - Fuel combustion process. Electro-magnetic forming: principle - essential of process - process variables - applications.

Explosive forming-Explosives-characteristics-stand off and contact operations, stress waves and their effects-requirements for standoff operations-process variables-properties of formed components-applications. Electro hydraulic forming-principles, requirements and

characteristics- process variables, Water hammer forming - principle and parameters governing the process.

REFERENCES:

1. An Introduction to the Principles of Metal Working, Rowe G.W, Edward Arnold Publication.
2. Mechanical Metallurgy, George. E Dieter McGraw-Hill International edition, Newyork,1988
3. Developments in High Speed Metal Forming, Davies. R and Austin. E.R., The Machinery Publishing Co. Ltd. London. 1970.
4. Fundamentals of Metal Forming, Robert H. Wagoner and Jean Loup Chenot., John Wiley & Sons Inc., New York, 1992.
5. Plasticity for Engineers, Calladine C. R., John Wiley & Sons, 1991.
6. Metals Handbook, Material Information Society, ASM, V4, Metals hand book, 1979.

COURSE OUTCOMES:

1. Understood the state of stress in various dimensions
2. Importance of flow curve in metal forming process
3. Calculation of working load in various forming processes
4. Different high speed energy forming process

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2			✓		
CO3				✓	✓
CO4	✓		✓		

MFEC104	**MECHANICS OF METAL MACHINING**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To impart fundamental knowledge on mechanics of chip formation
- To impart knowledge about tool failure analysis, and thermodynamics involved in metal cutting.
- To impart knowledge about wear-mechanisms of cutting tools and wear-chatter in machining.
- To provide an understanding of the mechanics of chip formation, tool failure analysis, and thermodynamics involved in metal cutting and the evolution of tool materials.

Need for rational approach to the problem of cutting materials-observation made in the cutting of metals-basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting-force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shafter theories-critical comparison.

Nomenclature of single point cutting tool-System of tool nomenclature and conversion of rake angles-nomenclature of multi point tools like drills, milling-conventional Vs climb milling, mean cross sectional area of chip in milling-specific cutting pressure

Heat distribution in machining - effects of various parameters on temperature - methods of temperature measurement in machining - hot machining - cutting fluids.

Tool failure: Mechanism of plastic failure – form stability, measurement of tool wear – tool life tests – tool life equation for variable theories – variables affecting tool life – economics of machining – machinability – machinability index – problems

Processing and Machining – Measuring Techniques – Reasons for failure of cutting tools and forms of wear-mechanisms of wear-chatter in machining-factors effecting chatter in machining-types of chatter-mechanism of chatter

REFERENCES:

1. Boothroid, D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, New York, 1989.
2. Shaw. M.C., Metal cutting principles, Oxford Clare don press, 1984.
3. Bhattacharya. A., Metal Cutting Theory and practice, Central Book Publishers, India, 1984.
4. Principles of metal cutting, Kuppusamy G., University Press, 1996.
5. The machining of metals, Armargeo, E.J.A. and Brown R.H. prentice Hall, 1969
6. Fundamentals of metal machining, Boothrough G., McGraw Hill, 1982.
7. Fundamentals of metal cutting and machine tools, Juneja B.L and Sekhar G.S, New age international, 1995.

COURSE OUTCOMES:

1. Understand the basic structures of concept of tools and tool materials.
2. Impart fundamental knowledge about forces and chips formed during the metal machining process.
3. Distinguish between orthogonal and oblique cutting.
4. Understand the Heat distribution during machining.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2	✓	✓	✓		
CO3			✓		
CO4	✓		✓	✓	

MFEC107	PRODUCTION ENGINEERING LABORATORY - I	L	T	P
		0	0	6

COURSE OBJECTIVES:

- To provide hands on experience on different materials processing techniques and to study the effect of process parameters on difference characteristics in material processing

LIST OF EXPERIMENTS:

1. Formability of sheet metals by water hammer technique
2. Rolling of metal strips
3. Temperature measurement in arc welding process
4. Influence of multi-pass welding on microstructure and hardness
5. Estimation of cutting forces by Merchant's theory
6. Power measurement in a lathe
7. Electric Discharge Machining
8. Abrasive Jet Machining
9. Estimation of flow stress by disc compression test
10. Phase diagram of a two-component system
11. Characteristic of moulding sand
12. Process capability

COURSE OUTCOMES:

Upon completing this course, students should be able to correlate the theoretical knowledge with the practical knowledge in the following areas,

1. Forming processes and its metallurgy
2. Welding processes and its metallurgy
3. Forces involved and power consumption during metal machining
4. Non-traditional machining processes
5. Casting processes and its metallurgy
6. Quality control

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓			✓	
CO2	✓			✓	
CO3	✓			✓	
CO4	✓			✓	
CO5	✓			✓	
CO6	✓			✓	

MFEC201	MANUFACTURING MANAGEMENT	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To introduce the operations management principles, and the related quantitative approaches, that helps in achieving the organizational goals.

Manufacturing management – Evolution and objectives - Concept of Production system - Types of Production systems – Continuous, Intermittent - Production versus Services
Forecasting - components of demand - Quantitative methods - Single moving average method - Single exponential smoothing method - Simple linear regression models – Seasonal model – Measures of accuracy - Simple problems - Qualitative Methods

Capacity planning: Defining and measuring capacity – determinants of effective capacity – Developing capacity alternatives. Aggregate planning: Costs, Strategies – Application of chase and level strategies - Transportation model - Simple problems.

Inventory planning and control: Need, inventory costs, Determination of EOQ, EPQ/ELS (without shortages) - Effect of quantity discounts. Determination of ROL, Safety Stocks – Service level - Methods of calculating safety stock using Normal distribution – unit service level - single period inventory model- Inventory control systems - P, Q, and S-s System – Selective inventory control techniques - Simple problems

Materials Requirements Planning (MRP) – Master production schedule, Bill of materials, MRP concepts, Lot sizing: Lot-for-lot technique, EOQ approach, Periodic order quantity approach – Simple problems. Concepts of manufacturing : Enterprise Resource planning (ERP) - TPM – pillars of TPM – six big losses – TPM implementation – Overall equipment effectiveness - Principles of JIT production – value added focus – sources of waste – Toyoto's seven waste – waste reduction – push pull system – Kanban theory – JIT implementation - JIT purchasing - Supply chain management

Scheduling and assignment problems - Notations and definitions – criteria, objective functions of scheduling – Job shop scheduling: Sequencing of n jobs through 1 machine – priority rules - Measures of Performance - n jobs through 2 machines – Jackson's rule - Simple problems. Flow shop scheduling – n jobs through 2, 3 machines – Johnsons rule, CDS algorithm, Palmer algorithm, Dannenbring algorithm, 2 jobs on m machines – graphical method – Multiproduct assignment problem - Index method - Simple problems

REFERENCES:

1. Production and Operations Management: Theory and Problems, Chary; S.N., TMH, New Delhi, 1990
2. Production and Operation Management, Paneerselvam R. PHI, 1999
3. Operation Management : Theory & Problems, Monks J. G., McGraw Hill, 1987
4. Production and Operations Management, Chase R.B., Aquilano N.J and Jacobs R.R., 8th e edition, TMH, 1998
5. Production Planning and Inventory Control, Narasimhan S.L., Mc Leavey D.W., and Billington P.J., 2nd Edition, PHI, 1997
6. Production and Operations Management, Jay Heizer and Barry Render, Prentice Hall Inc. fourth edition, 1996

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Develop an understanding of various types of production systems
2. Differentiate Production and services
3. Gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms
4. Develop the ability to identify operational methodologies to assess and improve an organizations performance
5. Gain ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making in the areas such as Aggregate planning, Inventory control, forecasting MRP and scheduling

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2	✓				
CO3	✓		✓		
CO4	✓			✓	
CO5	✓			✓	✓

MFEC202	**METAL JOINING TECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To provide the fundamental knowledge on basic physical metallurgy and welding metallurgy.
- To study about the weldability aspects of ferrous metals and non-ferrous metals.
- To know the details of various welding defects.
- To study about the weldability tests, Service tests and Corrosion test

Basic characteristics of fusion welds: Brief introduction to fusion welding process - Heat flow in welding: temperature distribution in welding, heat flow equations, simple problems, metallurgical effects of heat flow in welding, TTT diagrams, CCT diagrams - Metallurgy of fusion Weld: different zones of steel weldments and their properties, microstructure products in weldments.

Weldability of ferrous metals: Weldability of Carbon Steels, HSLA steels, Q&T steels, Cr-Mo steels, Significance of carbon equivalent, important problems encountered in welding of above steels and remedial steps - Weldability of Stainless Steels: stainless steel classification, Schaffler diagram, Delong diagram, WRC diagram problems associated with welding of austenitic stainless steel, ferritic stainless steel, martensitic stainless steel and duplex stainless steels.

Weldability of non-ferrous metals: Weldability of Aluminum alloys: Classification of aluminum alloys, various processes used for aluminum welding, problems involved in aluminum welding, precaution and welding procedure requirements, Weldability of

Titanium alloys: classifications of titanium alloys, various welding processes and procedures involved in titanium welding problems involved and remedial steps - welding of nickel base alloys and magnesium alloys.

Welding defects: Cracks: hot cracks, cold cracks, nomenclature, location and orientation of weld cracks, chevron cracks, lamellar cracks, reheat cracks, stress corrosion cracks - Residual Stresses: mechanism involved, types of residual stresses, measuring residual stress by hole drilling method, x-ray diffraction method, method of stress relieving, vibratory stress relief - Distortion: longitudinal, traverse, angular distortion, simple problems, bowing, rational distortion, buckling and twisting, controlling of distortions in weldments.

Weldability testing: Hot crack Tests: Murex test, Houldcroft test, Varestraint test, ring weldability test, hot ductility test - Cold Crack Tests: controlled thermal severity test, tekken test, lehigh test, longitudinal bead weld test, implant test - Service Weldability Tests: tensile test, nick break test, bend test, impact test, hardness test, fracture toughness test, fatigue test, creep test and corrosion test.

REFERENCES:

1. Welding Engineering and Technology, Parmar R.S, Khanna Publishers, New Delhi. 1998
2. Welding Metallurgy, Linnert G.E, Vol. I & II, 4th edition, American Welding Society, 1994
3. Introduction of Physical Metallurgy of Welding, Kenneth Easterling, 2nd Edition, Butterworth - Heinman, 1992
4. The Metallurgy of Welding, Saferian. D, Pergamon Press, 1985
5. Welding Metallurgy, Kuo S, Kohn Wiley, 1987
6. Welding Hand Book, Welding Process Vol. II 8th Edition, American Welding Society, 1991
7. Welding Hand book, Material and Application Vol.III, 8th Edition, American - Welding Society, 1991
8. Modern Arc Welding Technology, Nadkarni S.V, Oxford & IBH Publishing Co. Ltd., New Delhi

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Understand the basics of Physical Metallurgy, Welding Metallurgy and heat flow equations;
2. Studied about the Weldability of ferrous metals like Carbon Steels and High Strength Low Alloy Steels(HSLA);
3. Studied about the Weldability of Non- ferrous metals like aluminium, nickel and titanium
4. Understand and Inspect welding defects using Non-destructive testing methods;
5. Understand the Weldability testing , Weldability Service tests and Corrosion tests.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2		✓			
CO3		✓			
CO4				✓	
CO5					✓

MFEC203	METAL CASTING TECHNOLOGY	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To provide the knowledge on modern casting techniques, design of runners, risers, gating and casting defects, design considerations and modernization of foundries.

Modern casting techniques: Shaw process, slush casting, continuous casting, squeeze casting, Rheo casting, Thixo casting, Electro slag casting, Full mould process, Low pressure die casting, High pressure die casting.

Pouring: Gating design - Illustrative Problems in determination of filling time and discharge rate - Aspiration effect - Effects of friction and velocity distribution. Riser design and placement - determination of dimensions of riser - residual stress.

Solidification: Solidification shrinkages of pure metals and alloys - Effect of mould materials and alloy Composition on casting - Metal fluidity measurement and application of fluidity - gases in metals - degassing - grain refinement, Heat treatment of castings. Illustrative Problems related to determination of solidification time.

Casting defects and testing: Specification of castings - Inspection of castings - Analysis of casting defects - Quality control and quality assurance. Foundry mechanization: Principles and practice. Modernization of foundries: Pollution control-Energy saving- Layout for foundry. Material handling equipments: Sand handling, Mould handling, Core handling, Charge handling, Hot metal handling, handling of castings.

Casting design consideration: Design problems involving thin sections: Alloy selection, feeding through thin sections, non-uniform wall thickness, chilling effect of the mould. Design problems involving junctions - Design problems involving unequal sections: Padding, feed paths in permanent and investment castings.

REFERENCES:

1. Foundry Engineering, Howard F. Taylor, Merton C. Flemings, John Wulff, Wiley Eastern Limited, 1993
2. Fundamentals of Metal Casting Technology, Mukerjee. P.C, Oxford & IBH. Co., 1979
3. Principles of Foundry Technology, Jain. P.L, Tata McGraw-Hill Pub. Ltd., New Delhi,1997

4. Metal Casting - Principles and Practice, Ramana rao .T.V, New Age international, 1996
5. Manufacturing Science, Amitabha Gosh, Affiliated East-West Press,1985

COURSE OUT COMES:

Upon completing this course, students should be able to:

1. Understand the basic features and terminologies in casting process, gating, reserving system and their design aspects, the basics in solidification or the casting formation.
2. To obtain knowledge in the advanced casting process
3. Study the types of defects occurred in casting and provide remedial solutions.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓			
CO2	✓		✓		
CO3				✓	

MFEC204	**MACHINE TOOL DRIVES AND CONTROLS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- This course will give an appreciation of the fundamental principles, use of hydraulic and pneumatic components and systems for the control of various parts of machine tools
- To understand the working principle of hydraulic components and its selection
- To explore the use of different sensors, control valves, controllers and actuators for hydraulic circuits
- To provide a knowledge of trouble shooting and design of hydraulic circuits for different applications
- To impart knowledge on the design aspects of circuits for Machine Tool Control, the drive systems used for Machine Tools and N.C. systems and their programming languages

Machine Tool Drives: Selection of range of speeds and feeds – advantages of G.P series - Design of machine tool gear boxes. Types of drives: sliding clustered drives, Ruppert drives, Meander drives, Mechanical stepless drives.

Oil Hydraulics: Basics of Hydraulics drives : Application - Advantages of hydraulic control drives. Pump Classification: gear, vane, piston, Linear, Rotary- Fixed and Variable displacement pumps hydraulic pumps. Types of valves: Direction control, Flow control and Pressure control valves- Types, unloading - sequence valves, counter balance valves - Construction and Operation. Simple hydraulic circuits: Meter in, Meter out, Bleed off circuits, Regenerative circuits.

Fluidic control: Wall attachment principle – Types of amplifiers – Types of Logic elements – Types of Sensors – Simple logic circuits.

Numerical control: Introduction to numerical control – Application of NC machines – Economics of NC machines – Open loop – closed loop system – Interpolator – transducers – Comparators

Manual and Computer Aided Programming Languages: APT programming – Exercises in programming

REFERENCES:

1. Machine Tool Design and Numerical Control, Metha, N.K., Tata McGraw – Hill Publication
2. Industrial Hydraulics, John Pippenger and Tyler Hicks, McGraw Hill Co.
3. Machine Tool Design, Vol III and IV, Acherkan, N.S. MIR Publishers, Moscow
4. Programming for NC Machines, Roberts & Prentice, McGraw Hill
5. Computer Numerical Control of Machine Tools, Radhakrishnan., P, New Central Book Agency, Calcutta
6. Hydraulic Hand book, Warring R.H, Gulf Publishing Company
7. Principles of Machine Tools, Sen G.S, & Bhattacharya, New Central Book Agency, Calcutta

COURSE OUTCOMES:

After learning the course the students will be able to

1. Understand machine tool drives and their types
2. Identify hydraulic components and circuits
3. Ability to design simple logic circuits
4. Understand the benefits and applications of Numerical control machines.
5. Get the knowledge on the design aspects of circuits for Machine Tool Control, the drive systems used for Machine Tools and N.C. systems
6. Ability to develop N.C machines programming languages

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2			✓		
CO3				✓	
CO4	✓			✓	
CO5	✓		✓		
CO6					✓

MFEC207	**PRODUCTION ENGINEERING LABORATORY - II**	**L**	**T**	**P**
		0	**0**	**6**

COURSE OBJECTIVES:

- To train the students to make use of software for finite element analysis and statistical software packages for various applications in the field of manufacturing engineering.

Finite Element Analysis:

1. Study on Basic FEA, Nodes, Elements, Boundary Conditions.
2. One Dimensional FEA Problem.
    a. Truss structure analysis.
    b. Cantilever analysis.
3. Two Dimensional FEA Problems.
    a. Plane stress analysis.
    b. Temperature distribution analysis.
    c. Axisymmetric analysis.
    d. Contact element analysis.
4. Nonlinear FEA Problem
    a. Nonlinear Beam analysis.
    b. Geometrical nonlinear analysis.
    c. Material nonlinear analysis.
5. Three Dimensional FEA Problems.
    a. 3D Shell Analysis.
    b. 3D Analysis.
    c. 3D Beam
6. FEA Application in metal forming, metal cutting, fluid flow process etc.
    a. Velocity analysis of fluid flow in a channel

Statistical Analysis: Use of SPSS software: Construction of Charts - T-Test (Method – I and II) - Correlation and Regression – ANOVA – DOE – Factor Analysis – Cluster Analysis - Control Charts and Process Capability Analysis.

Use of Mathcad Software: Plotting of 2D graphs – Solving Linear Algebraic Equations – Discrete and Quadratic Function - Design Calculations.

COURSE OUTCOMES:

Upon successful completion of the course, the students are able to

1. Perform finite element modeling analysis of solid mechanics
2. Perform finite element modeling analysis of heat transfer problems, shell and contact problems in 2D and 3D.
3. Analyse and solve simple statistical problems using statistical software

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1		✓		✓	
CO2	✓		✓		✓
CO3		✓		✓	

MFES208	**SEMINAR**	**L**	**T**	**P**
		0	**0**	**2**

COURSE OBJECTIVES:

- To work on a technical topic related to Manufacturing Engineering and acquire the ability of written and oral presentation
- To acquire the ability of writing technical papers for Conferences and Journals

The students will work for two periods per week guided by student counsellor. They will be asked to present a seminar of not less than fifteen minutes and not more than thirty minutes on any technical topic of student's choice related to Manufacturing Engineering and to engage in discussion with audience. They will defend their presentation. A brief copy of their presentation also should be submitted. Evaluation will be done by the student counselor based on the technical presentation and the report and also on the interaction shown during the seminar.

COURSE OUTCOMES:

1. The students will be getting the training to face the audience and to interact with the audience with confidence.
2. To tackle any problem during group discussion in the corporate interviews.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓		✓	✓	
CO2	✓			✓	

MFET303	**THESIS PHASE – I**	**L**	**T**	**P**
		0	**4**	**0**

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Take up any challenging practical problems and find solution
- Learn to adopt systematic and step-by-step problem solving methodology

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓			✓
CO2		✓		✓	

MFEI304	**INDUSTRIAL TRAINING**	**L**	**T**	**P**
		0	*****	**0**

COURSE OBJECTIVES:

- To train the students in the field work related the Manufacturing Engineering and to have a practical knowledge in carrying out Structural field related works.

- To train and develop skills in solving problems during execution of certain works related to Manufacturing Engineering.

The students individually undergo a training program in reputed concerns in the field of Manufacturing Engineering during the summer vacation (at the end of second semester for full – time / fourth semester for part – time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training he had, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

COURSE OUTCOMES:

1. The students can face the challenges in the practice with confidence.
2. The student will be benefited by the training with managing the situation arises during the execution of works related to Manufacturing Engineering.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1			✓	✓	
CO2				✓	✓

MFET401	**THESIS PHASE – II**	**L**	**T**	**P**
		0	**8**	**0**

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Take up any challenging practical problems and find solution
- Learn to adopt systematic and step-by-step problem solving methodology

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓			✓
CO2		✓		✓	

MFEEXXX	MAINTENANCE MANAGEMENT	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To impart a better understanding of the fundamental philosophies of Maintenance Management, and the different techniques that enable the selection of the optimum maintenance strategy. It also discuss the concepts of reliability engineering and spare parts management

Maintenance system: Types of Maintenance - Maintenance strategies and planning – quantitative analysis – Breakdown – time frequency distributions – Breakdown maintenance policy, preventive maintenance policy- Selection of repair Vs preventive maintenance policy – simple problems. Introduction to TPM – six big losses – pillars of TPM – 5s – Overall Equipment Effectiveness (OEE)

Maintenance facilities planning: Planning of Maintenance Function – Long range planning – Short range planning – Man power allocation - Planning techniques – Planning steps - Optimal number of machines / crew size - Use of waiting line and Simulation model.

Replacement strategies and Policies: Basic concepts of replacement analysis, economic service life, opportunity costs - cash flow approaches to replacement analysis - Replacement analysis using specified time period - probabilistic replacement models – simple problems

Reliability Engineering: Bath tub curve - Failure data analysis and life testing – Reliability parameters – Reliability models – Reliability evaluation methods – Weibull analysis – System reliability with components in series, parallel and mixed configuration – Active, partial and standby redundancy – Availability and Maintainability concepts - Reliability centered maintenance – FTA, FMECA.

Spares management: Spare parts management - Characteristics of spare parts inventory – Approaches for selective inventory control – VED/ABC analysis – Models for breakdown spares, capital spares, insurance spares and rotable spares – simple problems. Introduction to Maintenance Resource Planning (MRP) – maintenance Manpower Resources and Spares Requirement Planning (MRSRP).

REFERENCES:

1. Production and Operations Management: Theory and Problems, Chary S.N., TMH, New Delhi, 1990
2. Operation Management: Theory & Problems Monks J.G., McGraw Hill, 1987
3. Concepts in Reliability Engineering, Srinath L.S., East west press Ltd. 1991
4. Terrotechnology: Reliability Engineering and Maintenance Management, Bikas Bhadury and S.K. Basu, Asian Books Pvt., Ltd., New Delhi, 2003
5. Introduction to Total Productive Maintenance, Seiichi Nakeiima, Productivity Press (India) Pvt Ltd., Madras, 1988
6. Maintenance and Engineering Management, Mishra R.C., Pathak K., Prentice hall India Private Limited, New Delhi, 2002

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Develop a maintenance plan for a technical system
2. Have a working knowledge of the techniques of reliability engineering
3. Apply learned concepts to improve the maintenance, the maintainability, hazard risk and the safety of the plant
4. Apply problem solving models to maintenance
5. Analyze different failure of a component/equipment

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1		✓	✓		
CO2	✓			✓	
CO3				✓	
CO4				✓	✓
CO5					✓

MFEEXXX	**COMPUTER INTEGRATED MANUFACTURING SYSTEMS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To familiarize the basic concepts of CIM
- To introduce the fundamentals of robotics and its applications in manufacturing industries
- To introduce the concept of FMS and the materials handling and storage system used
- To familiarize the group technology concept and the clustering algorithms associated with it.
- To introduce the concepts of CAPP and CAQC

Introduction to CIM: An overview of CIM – Significance – Product development through CIM – Design and Implementation – CIM models – Present status.

Industrial Robotics: Automation and Robotics – Robot Anatomy, Joint motions – End effectors: Grippers and Tools – Robotic sensors – Robot vision system – Robot programming – Robot cell: Types – Design and control. Applications of Industrial Robots in Material transfer, Machine loading/unloading, Welding, Spray coating, Processing operations, Assembly and Inspection, Advanced Applications.

Flexible Manufacturing System (FMS): Definition – Components – Types – Flexibilities – Materials Handling and storage system: Conveyors: Types – Automated Guided Vehicle (AGV): Types, Guidance and Routing – Automated Material Handling and Storage system (AS/RS): Types, Components and Special features – Carousel system – WIP storage – Role of computers in FMS – FMS Layouts – Benefits of FMS.

Group Technology (GT): Part family – Parts classification and coding – Cellular Manufacturing – Benefits of GT. Algorithms for Machine cell formation: Algorithms based on similarity coefficients: Single Linkage Clustering Analysis (SLCA), Algorithms based on

sorting of Part-Machine Incidence Matrix: Production Flow Analysis (PFA) – Rank Order Clustering (ROC), Cluster Identification Algorithm (CIA) – Cellular Layouts.

Automated Process Planning: Generative and Variant types of process planning – AI in process planning – Software. Computer- Aided Quality Control (CAQC): Overview – Inspection Technology: Types of Coordinate Measuring Machines (CMM) – Non-contact inspection methods – Machine vision system.

REFERENCES:

1. Mikell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicolas G. Odery, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill Book Co., 1986
3. Radhakrishnan, P., Subramanyam, S, and Raju, V., CAD/CAM/CIM, Second Edition, New Age International Pvt., Ltd., 2002
4. Deb, S.R., Robotics Technology and Flexible Automation, Tata McGraw-Hill Publishing Co. Ltd., 1996

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Become familiar on the basic concepts of CIM and its importance in the global competitive market
2. Understand the anatomy of industrial robots and their application in various areas of manufacturing
3. Understand the concepts of FMS and materials handling and storage systems used
4. Understand the usage of group technology concept and clustering algorithms in modern manufacturing systems
5. Get familiarize with the concepts of CAPP, CAQC and the usage of CMM.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓		✓		
CO2	✓		✓		
CO3	✓				✓
CO4	✓				✓
CO5	✓	✓			

MFEEXXX	**PLANT LAYOUT & MATERIAL HANDLING**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To introduce the concepts of layout planning and the various algorithms used in and also to introduce the design of material handling systems, mechanized assembly, hoppers and feeders and transfer systems.

Plant Layout: Need for Layout Planning – Layout Objectives and Determinants. Process Layout: Operation Sequence Analysis – Load-Distance Analysis – Travel Chart – Muthur's

systematic layout planning – Pair-wise Exchange Method–Simple Problems. Product Layout: Line Balancing– Largest Candidate Rule – Kilbridge & Wester's Method – Ranked Positional Weight Method – COMSOAL.

Apples plant layout procedure – Reed's plant layout procedure - Computer Aided Plant Layout Planning: CORELAP, PLANET, MAT, ALDAP, CRAFT - Plant Layout Algorithms: Modified spanning tree algorithm – Graph based method – BLOCPLAN Algorithm

Facilities planning - Introduction to models for single row machine layout problem - multi-row layout problem and quadratic assignment model - introduction to algorithms for the multi-row layout problems.

Material Handling Functions - Principles - Types of Material Handling Systems. Analysis of Material Handling Equipment. Economic Analysis of Material Handling Equipments: Breakeven Analysis – Equipment Operating Cost Per Unit Distance – Work Volume Analysis – Illustrative Problems. Productivity / Indicator Ratios. Packaging: Functions – Materials – Palletizing – Packaging Equipments.

Mechanized Assembly: Principles and Operating characteristics of Part Feeders such as Vibratory Bowl Feeder, Reciprocating Tube Hopper, Centrifugal Hopper Feeder and Center Board hopper feeder – Orientation of Parts – In-bowl and Out-of-bowl tooling – Different Types of Escapements Transfer Systems and Indexing Mechanisms.

REFERENCES:

1. Material Handling, John R. Immer, McGraw Hill Book Coy, 1953
2. Facility Layout and Location: An Analytical Approach, Francis R. L., McGinnis L. F., & White J. A., PHI, 1999
3. Manufacturing Facilities: Location, Planning & Design. Sule D. R., PWS Publishing Co., Boston, 2nd Edition, 1994
4. Facilities Design, Sunderesh Heragu, PWS Publishing Co., Boston, 1997
5. Materials Management & Materials Handling, Sharma S. C., Khanna Publishers, New Delhi
6. Production and Operations Management – Principles and Techniques, Ray Wild, ELBS
7. Analysis and control of production systems, 2nd edition, Elsayed A., and Thomas O. Bouchar Prentice Hall, NJ, 1994
8. Theory and Problems in Operation and Production Management, Chary S. N., Tata-McGraw Hill, 1994
9. Mechanised Assembly, Boothroyd & Redford
10. Automation, Production Systems and Computer-Integrated Manufacturing, Groover M.P., PHI, New Delhi, 2002
11. Facilities Planning, III Edition, Tompkins, White, Bozer, Tanchoco, John Wilery & Sons Pvt.Ltd, Singalore, 2003

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Understand the different layout planning techniques
2. Apply layout planning techniques for solving layout problems
3. Carryout economics analysis of material handling equipments

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2		✓	✓		
CO3				✓	✓

MFEEXXX	**COMPOSITE MATERIALS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To impart an in-depth knowledge on composite materials, types, production processing and the structural development in composite materials.

Introduction: Fundamentals of composites – need for composites – Enhancement of properties – classification of composites - Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) Reinforcement - Particle reinforced composites, Fibre reinforced composites, Applications of various types of composites.

Classification .of Polymers - properties and applications of selective engineering polymers - Polymer Matrix Composites: Polymer matrix resins - Thermosetting resins, thermoplastic resins - Reinforcement fibres - Rovings - Woven fabrics - Non Woven random mats - various types of fibres. PMC processes - Hand layup processes - Spray layup processes - Compression moulding - Reinforced reaction injection moulding - Resin transfer moulding - Pultrusion - Filament winding - Injection moulding. Fibre reinforced plastics (FRP), (Glass fibre reinforced plastics (GRP)).

Metal Matrix Composites: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC. Limitations of MMC, Metal Matrix, Reinforcements particles - fibres. Effect of reinforcement - Volume fraction - Rule of mixtures, Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting, squeeze casting.

Ceramics Matrix Composites: Engineering ceramic materials - properties - advantages - limitations - Monolithic ceramics - Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites - oxide ceramics - non oxide ceramics aluminium oxide - silicon nitride - reinforcements particles - fibres - whiskers. Sintering - Hot pressing Cold isostatic pressing (piping) - Hot isostatic pressing. (HIPing)

Advances Composites: Carbon/carbon composites - Advantages of carbon matrix - limitations of carbon matrix Carbon fibre - chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace industrial applications.

REFERENCES:

1. Composite materials, Engineering and Science, Mathews .F.L. and Rawings .R.D., Chapman
2. Composite materials, Chawla K.K., SpringerVerlag, 1987
3. Engineering Materials, Kenneth G.Budinski, Prentice Pvt. Ltd., 41th Indian Reprint, 2002

4. Introduction to Metal Matrix Composites, T.W.Clyne and P.J. Withers, Cambridge University Press, 1993
5. Fundamentals of Composite Manufacturing, B. Strong, SME, 1989
6. Composite materials, S.C. Sharma, Narosa Publications, 2000
7. "Short Term Course on Advances in Composite Materials", Composite Technology Centre, Department of Metallurgy, lIT - Madras, December 2001
8. Hand Book of Plastic processing, Brydson,
9. FRP Technology (Fibre Reinforced Resin System), Weatherhead, R.G Applied Science Publishers Limited, London, 1990

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Obtain knowledge on classification of composite materials used in the modern world
2. Obtain knowledge on different types of production technique of composite materials
3. Acquire knowledge on production of light weight composites that are used in aerospace industries

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓			✓	
CO2	✓			✓	
CO3	✓			✓	✓

MFEEXXX	**TOOL ENGINEERING**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To introduce different production tools, including press tools, their design,
- To provide an understanding of design and use of jigs and fixtures.
- To introduce the students, the modern concepts of tool engineering

Design principles of cutting tools – problems in cutting tool design – factors in tool design – Single point cutting tool – chip breakers – determination of tool shank dimensions. Milling cutters – determination of number of teeth, teeth size and other features. Design features – drills – reamers - broaching tools.

Press tool design: Press classification – selection and features of press. Dies – types – clearances. Progressive die design for typical components for blanking and piercing – compound die –combination die – Illustrative examples. Strip layout design – influencing factors

Bending: Types of bending – determination of bending force – bend allowance – Springback. Drawing dies: Design of dies – blank development – Cup drawing - illustrative examples. Ironing – calculation of number of draws. Design of forging dies – blank size, materials for die block.

Elements of Jigs and Fixure – Locating and clamping principles. Locating method and devices – Clamping devices. Types of Jigs: Plate, Template, Latch, Channel Leaf, Box and Indexing.

Modular work holding systems – quick change toolings - single minute exchange of dies – Computer aided fixture design – phases. Plastic tooling – Plastic tool materials – construction methods – applications. Safety aspects of tool design – criteria for selection of tool material

REFERENCES:

1. A Text Book of Production Engineering, P.C. Sharma, S.Chand, 2001
2. Tool Design, Donaldson G.H, Lecain, Goold V.V, TMH, 2000
3. Cutting Tool Design, Rodin P., MIR Publisher, Moscow, 1968
4. Die design Hand book, Wilson F.W., McGraw Hill
5. Fundamentals of Tool Design, ASTME, Prentice Hall, 1974

COURSE OUTCOMES:

Upon completing this course, students should be able to

1. Develop an understanding of the cutting tool nomenclatures
2. Develop and design of progressive and compound dies for simple sheet metal operations
3. Calculate bending force, number of draw for the required cup shape, blank size for forged components.
4. Understand the modern techniques of tool engineering and the various phases in computer aided fixture deign
5. Acquire knowledge about the plastic tool materials and development methods

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓			✓	✓
CO2		✓	✓	✓	1.
CO3	✓				✓
CO4		✓			2.
CO5			✓	✓	3.

MFEEXXX	**AUTOMOTS AND TRANSFER MACHINES**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- The aim of present course is to introduce the students about the basic automation theory and understanding of its devices. Students can think and get innovative idea in the area of shop floor automation.

Automation introduction: Automated Manufacturing System, Reasons for Automating, strategies for automation and process improvement, automation migration strategies, levels of automations, Types of Automations. Classification of Automatic Machines

Pneumatic System Design: Introduction, pneumatics system components, pneumatics actuators, application of pneumatics system in automation, pneumatics circuit design for automation, limitations of pneumatic system.

Hydraulics System Design: Introduction, Hydraulic system components, hydraulic actuators, application of hydraulic system in automation, hydraulic circuit design for automation, limitations of hydraulic system.

Automated Machinery: Introductions, Automated transfer machine, automated transfer line, Continuous and rotary transfer line , auto-storage and retrieval system, automated guided vehicles, automated material handling system, automated inspection system and CMM.

Industrial Robotics and Mechatronics System: Introduction, Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Sensors in Robotics, Industrial Robot Applications, Robot Programming overview. Transducers, Sensors and Actuators: Classification, Principle of Operation, Selection Criteria, Signal Conditioning, Calibration.

REFERENCES:

1. Automation, Production Systems and Computer Integrated Manufacturing Mikell P. Groover, P.H.I. Learning Private Limited
2. Hydraulics and Pneumatics Andrew Parr, JAICO Publishing Home, Ahmedabad
3. Industrial Automation and Robotics A. K. Gupta and S. K. Arora, University Science Press, Laxmi Publishing Pvt. Ltd.
4. Programmable Logic Controller Vijay R. Jadhav, Khanna Publishers, New Delhi
5. Robotics and Control R. K. Mittal and I. J. Nagrath, McGraw Hill Education (India) Private Limited
6. Automatic Machine Tools –Town H.C
7. Assembly automation and product design, Boothroyd . G

COURSE OUTCOMES:

Upon completing this course, students should be able to

1. Develop knowledge and skill to design of hydraulic, pneumatic and electro-pneumatic logic circuits for automating processes in manufacturing
2. Demonstrate problem-solving skills in automation and safely use the machines in the industries
3. Explore the use of different sensors, control valves, controllers and actuators for electro-pneumatic & hydraulic circuits

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓			✓	✓
CO2		✓	✓	✓	
CO3	✓				✓

MFEEXXX	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P
		4	0	0

COURSE OBJECTIVES:

- Understand the relationship between customer desires, functional requirements, and product design.
- The aim is to make the student aware of fits and tolerance that are used in the industry.
- To make students aware of the necessity to produce best design processes and systems for the best use of material.
- To acquaint the students with recent developments in reverse engineering and rapid prototyping.
- To aid in efficient in design to minimize material usage on an application perspective

Fits and tolerance -Terminology for limits and fits, general limits of tolerance, limit system, selective assembly- problem. Gauges and gauge design-Plain gauge, design of limit gauges, manufacturing of limit gauges, choice of limit gauges-problem.

Jigs and fixtures -Design principles common to jigs and fixtures, fundamentals of jigs and fixtures design, materials for jigs and fixtures, construction-problem.

Forging -Die design for machine forging, determination of stock design, selection of forging equipment, size of die blocks-problem. Extrusion -Design of parts of extrusion block, analysis of extrusion process, variation of extrusion pressure-problem. Sheet metal drawing - Press selection, cutting forces, methods of reducing cutting forces, blanking die design, piercing die design, pilots, drawing die, bending dies, design procedure for progressive dies.

Welding-Basic consideration, introduction, critical dimensions of weld connections, stress analysis in static loading, tensile load in butt welds, bending load in butt welded joints, fillet welds, concentric and eccentric loading of fillet welds, some typical structural parts, design of spot welds and plug welds-problem.

CMM, reverse engineering, rapid prototyping, 3D printer, design to minimize material usage, design for assembly, design for recyclability.

REFERENCES:

1. P.C, Sharma, “Production engineering”, S. Chand and Co. Pvt. LTD. New Delhi.
2. V.M. Radhakrishnan, “Welding technology and design”, New age international publishers.
3. Chua C.K, Leong K.F and Lim C.S, “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2010.
4. Liou L.W and Liou F.W, “Rapid prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007.

COURSE OUTCOMES:

1. Students will have ability to understand contemporary issues and their impact on design for manufacturing and assembly.
2. The student will be able to understand the latest design processes in the field of manufacturing technology.

3. Apply a systematic understanding of knowledge in the field of extrusion, sheet metal drawing and forging.
4. Ability to develop a project on design and product development, considering advanced production technologies.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2	✓	✓			
CO3			✓	✓	
CO4					✓

MFEEXXX	**IMPACT ENGINEERING**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To impart an in-depth study of impact engineering with a focus on the current status of explosive metal working.
- To familiarize the basic concepts of explosive forming process
- To introduce the fundamentals of explosive welding and cladding of metals
- To introduce the effect of explosive forming processes
- To introduce the concepts of high temperature measurement in compaction techniques

Explosives - Types - Propagation of ideal detonation - reaction zone. Shock waves - general considerations - Pressure, Impulses and energies of shocks generated by explosions in air and water Mechanics of energy transfer - ecometrical method - bubble phenomenon.

Stand-off and contact operations - parameters and applications. Interaction between explosion and work Piece in contact operation - Pressure time relation in metal- explosive system. Stress waves in solids - Microstructural changes - Hugoniot curves for iron and brass - changes in physical properties - fracturing under impulsive loads

Explosive welding of metals - Mechanism- Jetting collision Karman Vortex - Welding of semi cylindrical parallel plates - parameters welding window of dynamic angle of obliguity and velocity of welding - Transition from smooty to wavy flow - Loyer's welding window different types of explosive cladding setup - multilayered welding Applications - Metallurgy of explosive welding.

Explosive forming - strain energy of deformation - effect of explosive stand off and strain distribution in the explosive forming of flat circular blanks - Simple problems - Multiple shot explosive forming - Use of scale models in explosive Conning -explosive Conning dies- Effect of explosive forming on materials properties

Shock consolidation ceramics and composites - shock waves. The jump-relations- Equation (Hugoniot) – Compaction mechanism static versus shock compaction - different shock compaction techniques - (Cylinrical, Converged, Underwater and high temperature) -

Temperature measurements - shock consolidation of bio-compatibles - ceramics - melt - infiltration of shock compacted ceramics - Metallurgy of shock consolidation

REFERENCES:

1. Explosive working of metals and its applications, Bernard Crossland, Oxford University Press, 1983
2. Explosive working of metals, Jolm Rineheart and John Pearson, Pergamon, London, 1985
3. Development of High Speed Forming, Davies and Austin, ASTME, 1976
4. High velocity forming of metals, Wilson, Prentice Hall of India Private Ltd., 1976

COURSE OUTCOMES:

1. Understand the processes variables generated by explosions
2. Protect the metals from surface damages.
3. Understand the environmental factors affecting the atmospheric contaminations
4. Evaluate the high temperature explosive properties of metals.
5. Studying the metallurgical properties of explosive cladded process

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓		✓		
CO2		✓			✓
CO3					
CO4		✓		✓	
CO5					

MFEEXXX	**PRECISION ENGINEERING AND NANO-TECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To impart fundamental knowledge on Precision Engineering
- To impart knowledge about Nano Technology

Introduction: Definition - Introduction to Precision Engineering and Manufacturing- Accuracy, Repeatability - Principles of Measurement - Precision Flexure Design. Precision Optical Manufacturing - Micro - Optics - Precision Machine Design - Micro - Sensors: Design - fabrication - Testing and packaging.

Principles: Principles and Application of precision Engineering to the design of Instruments and Manufacturing Equipment. Principles of Metrology – Accuracy and Resolution - Sensors, Actuators. Bearings flexures for Precision Motion Generation.

Precision Manufacturing: Manufacturing Methods in Precision Engineering - Joining Technologies - Finishing processes - Special Casting techniques - Etching techniques - Coatings with metals & Inorganic Materials - Optical Production Methods - Vacuum Deposition MEMS & Micro Machining.

Nano Technology & Instrumentation: Nano Technology - Introduction to Scanning Probe Microscopy (SPM) - contact mode, Tapping Mode, Scanning Tunneling Mode (STM), Atomic Force Microscope (AFM), Advanced SPM - Electrostatic Force Mode (EFM)- Magnetic Force Mode(MFM)- Scanning Capacitance Mode (SCM), Nano-indentation - High Resolution, Drexlerian Nano Technology. Introduction to biological Applications, Quantum Effects & Futures, Quantum Dots, Quantum Computing

Smart structures, Materials and Micro Actuators: Smart structures – smart sensors – micro valves – MEMS - micro motors - micro pumps - micro dynamometer - micro machines - structures assembly - cooling channels - micro optics - micro nozzIes.

REFERENCES:

1. Principles of Precision Engineering, NakazawaH. Oxford University press, 1994.
2. Nano Technology, Mark Ratner and Daniel Ratner, Pearson Education, Delhi 2003.
3. Precision engineering in Manufacturing, Murthy.R.L. New Age international Pvt. Limited.
4. Hand book of Surface and Nano Technology, D.J. White House.
5. Institute of Physics Publishing, Bristol and Philadelphia, Bristol. BSI 6BE U.K.
6. The Science and Engineering of Micro-electronic Fabrication, Stephen A. Campbell, Oxford University Press, 1996.
7. Understanding Smart Sensors, Randy Frank, Artech. House, Boston, 1996.

COURSE OUTCOMES:

1. Understand the basic concepts of Precision Engineering.
2. Impart fundamental knowledge about MEMS.
3. Evaluate the Quantum Effect Futures
4. Design the smart materials for specific applications.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓		✓		
CO2		✓			✓
CO3		✓			
CO4		✓			✓

MFEEXXX	**NANO MATERIALS TECHNOLOGY**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- This course has been designed to provide in depth knowledge on nano materials fabrication methods, characterization techniques and application of nano materials

Introduction to nano technology : Scientific revolutions - Types of nanotechnology and nanomachines - The periodic table - Atomic structure - Molecules and phases - Energy - Molecular and Atomic Size, Surfaces and Dimensional space - Atoms by inference - Scanning probe microscopy: atomic force microscope - Scanning tunneling microscope – Nanomanipulator, Nanotweezers - Atom Manipulation - Nanodots - Self assembly - Dip pen nanolithography.

Nanopowders and Nanomaterials: Classification of nano materials - Properties of nano materials - characteristics of nano particulate materials; Production Methods: Top down approach - mechanical milling, Chemical Etching, Electro explosion, Sputtering, Laser ablation; Bottom up approach Plasma spraying, Chemical vapour deposition, Sol Gels, Laser pyrolosis, Atomic or molecular condensation.

Characterisation and Detection Techniques: Atomic structure and chemical composition: spectroscopic methods, vibrational spectroscopies, Nuclear magnetic resonance, X-ray and UV spectroscopies, X-ray and neutron diffraction. Determination of size, shape and surface area: Electron microscopes, BET and pycnometry, Ephiphaniometer, Laser granulometries and Zeta potential, Elliptically polarised light scattering; Determination of nanoparticles in aerosols and in biological tissues

Applications of Nanomaterials: New forms of carbon - Types of Nanotubes - Formation of Nanotubes - Assemblies Purification of carbon nanotubes - Properties of Nanotubes - Uses of Nanotubes: electronics, hydrogen storage, materials, mechanical machines - Space elevators. Application of Nanomaterials : insulation materials, machine tools, batteries, high power magnets, motor vehicles and aircraft, medical implants and other medical uses,- Nanocomposites and Nanowires.

Applications of Nanotechnology: Nanotechnology in industries - Nanotechnology in computing: quantum computing and molecular computation - Nanotechnology in electronics: computational nanotechnology and optoelectronics, mechanical nanocomputers, super computing systems Nanotechnology in health and life sciences: drug delivery, drug encapsulation, tissue repair and implantation, biorestorable materials - Nanotechnology in smart materials: sensors and smart instruments, ageless materials, nanoparticle coatings.

REFERENCES BOOKS:

1. Nanotechnology: Basic Science and Emerging Technologies, Michael Wilson and Geoff Smith, Chapman and Hall, London, 2002
2. Industrial application of nanomaterials - chances and risks, Wulfgang Luther, Future Technologies Division, Germany, 2004
3. Nanotechnology: Applications and Trends,J.Schulte, John Wiley and Sons, 2005
4. Nanotechnology, G.L.Timp, Springer-Verlog, New York, 1999
5. Handbook of Nanotechnology, Editor: B.Bhushan,SpringerVerlog, New York, 2004

COURSE OUTCOMES:

1. Understand the basics of nano sized materials
2. Understand the difference between bulk and nano materials
3. Understanding the production methods of nanomaterials
4. Applications of nanomaterials
5. Usage of nanomaterials in biological applications

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓				
CO2		✓			✓
CO3			✓	✓	
CO4					✓
CO5					✓

MFEEXXX	**ENGINEERING ECONOMICS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To enable students to understand the fundamental economic concepts applicable to engineering and to learn the techniques of incorporating inflation factor in economic decision making towards the design and manufacturing problems.

Introduction to Economics: Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

Value Engineering: Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor – Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

Cash Flow: Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method - Examples in all the methods.

Replacement and Maintenance Analysis: Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return.

Depreciation: Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Examples on comparison of alternatives and determination of economic life of asset.

REFERENCES:

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2001.
2. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.

3. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010.
4. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2011.
5. Zahid A khan: Engineering Economy, “Engineering Economy”, Dorling Kindersley, 2012

COURSE OUTCOMES:

Upon successful completion of this course, students will

1. Acquire the knowledge on basics of economics
2. Develop skills to apply cost analysis to engineering and take economically sound decisions.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓			✓
CO2			✓	✓	

MFEEXXX	**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To discuss the different views of quality and to appreciate the importance of product quality, to provide a knowledge understand a framework summarizing the philosophical elements and generic tools of TQM to provide an understanding of the role of quality control and Acceptance sampling plans in organizations.

Concepts of TQM – Dimensions of Quality - Deming, Crosby and Juran’s Philosophies – Barriers to TQM - Quality system – ISO 9000:2000, ISO 14000 Quality system standards - Quality costs, Seven tools for Quality Control, Seven tools for Quality management, Quality Function Deployment (QFD) – Taguchi loss function

Statistical Process Control: Control charts for attributes and count of defects – p chart, np chart, c chart, u chart.

Control charts for variables – $\bar{X}$ chart, R chart, σ chart – process capabilities studies (C_p and C_{pk}) – Concept of Six sigma. Special control charts – Group control chart, sloping control chart, moving averages and moving ranges control charts, coefficient of variation control chart.

Acceptance sampling plans for attributes: Concepts – Difference between inspection and quality control - single sampling plan - OC curve. Reliability Engineering: Definition – Bath tub curve - MTBF – MTTF - System reliability with components in series, parallel– FTA, FMECA.

REFERENCES:

1. Introduction to Statistical Quality Control, Montgomery D.C., John Wiley, 1994

2. Statistical Quality Control, Gupta R.C., Khanna Pub., 1998
3. Amitava Mitra, "Fundamentals of quality control and improvement", prentice hall, 2nd edition, 1998
4. Besterfield, "Total Quality Management", Pearson Education, 2nd Edition, 2003
5. Mahajan,M., " Statistical Quality Control", dhanpat rai & co., pvt ltd, 2010
6. The Assurance Sciences, Halpern Siegmund, PHI, 1978
7. Concepts in Reliability Engineering, Srinath L.S., Eastwest Press Ltd., 1991. IS 397 Part I, II and III, IS 2500

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Understand the core features of the total quality management in terms of various dimensions of quality.
2. Measure the cost of poor quality and process effectiveness and efficiency to track performance quality and to identify areas for improvement
3. Develop an understanding on quality management philosophies and frameworks
4. Develop the ability to apply the tools of quality control and quality management.
5. Understand proven methodologies to enhance management processes, such as benchmarking and business process reengineering, lean manufacturing.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓		✓	
CO2		✓	✓	✓	
CO3	✓	✓	✓	✓	
CO4			✓	✓	✓
CO5		✓		✓	

MFEEXXX	**SUPPLY CHAIN MANAGEMENT**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- Discuss the fundamental concepts of supply chain management; impart the knowledge on how to align the management of a supply chain with corporate goals and strategies.

Introduction to Supply Chain Management- Definition- Decision phases in supply chain, Process Vs Push pull view of supply chain-The development chain - Design the right sc-functional Vs innovative products- product life cycle and SC design – clock speed.

Supply chain (SC) performance and evaluation: Order Winning to Order fulfillment- SCOR Model – Balance Score card model. SC Strategies: Efficient Vs Responsive strategy- Agile Vs Lean supply chain, postponement strategy- push pull strategy.

Value of Information- Bullwhip effect- information and supply chain technology- Supply chain integration- Concepts of MTO, MTS, ETO and ATO -demand driven strategies- impact of internet on SCM-

Supply network – factors influencing supply chain network design - distribution strategies VAT material flow analysis. Strategic alliances – Make or buy decision – Framework for strategic alliance – outsourcing - Krajalic matrix - core competency – 3PL- 4PL – Effect of Demand and supply uncertainty- cross docking- - risk pooling- Square root law -centralized vs decentralized system

Global SC - International Issues in SCM- Introduction- risks and advantages- design for logistics- supplies integration into to new product-development- mass customization- Issues in customer value – Information technology for SCM- Goals - standardization- infrastructure- DSS for supply chain management.

REFERENCES:

1. Designing and managing the Supply Chain, Simchi - Levi Davi, Kaminsky Philip and Simchi-Levi Edith, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2003
2. Supply chain management, 2nd edition, Sunil Chopra and Peter Meindl, Pearson Education, New Delhi, 2003.
3. Supply Chain Management: Text and Cases, Janat Shah, Pearson Education India, 2009.
4. Supply Chain Management, Robert B Hand Field and Ernest Nichols, Prentice Hall, New Jersey, 1999.
5. Supply chain management: concepts, techniques and practices, Ling Li, world scientific press, 2011
6. Supply chain management (Theories & practices), R Mohanty andS G Deshmukh, Ist edition, Biztantra innovation in management, 2005

COURSE OUTCOMES:

Upon completing this course, students should be able to:

1. Understand the roles of supply chain among various business functions and their roles in the organizations' strategic planning and gaining competitive advantage
2. Able to actively employ supply chain management methodologies
3. Able to apply supply chain techniques in both manufacturing and service industries
4. Analyze the principles, concepts and challenges for developing sourcing, manufacturing and distribution strategies in a global market.
5. Describe the role of information technology to improve the performance of the supply chain

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	
CO4	✓		✓	✓	
CO5	✓		✓		✓