DEPARTMENT OF MECHANICAL ENGINEERING

Course Book for

M. Tech. in

Production & Industrial Engineering

For

Academic Year
2025- 2026

Visvesvaraya National Institute of Technology,

Nagpur-440 010 (MH)

Institute Vision Statement

To contribute effectively to the National and International endeavor of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country and the World incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

Institute Mission Statement

The mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. VNIT is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

Department Vision Statement

To produce quality human resource of high standard in mechanical engineering who can contribute favorably to the technological and socio-economic development of the nation.

Department Mission Statement

To develop state of the art facilities related to mechanical engineering. To attract highly qualified faculty to the mechanical engineering department. To promote participation of industries in academics, research and consultancy. To undertake research at regional and national level.

Brief about Mechanical Department

Department of Mechanical Engineering is one of the oldest department started in 1960, currently department is offering 1 UG and 4 PG programmes. Faculty members of the department are highly motivated for teaching and conducting research in the diversified fields of mechanical engineering.

List of Faculty Members

Sr No	Faculty Name	Areas of specialization
1	Dr. A. M. Kuthe	Manufacturing
2	Dr. S. B. Thombre	Thermal Engineering
3	Dr. V. R. Kalamkar	Thermal Engineering
4	Dr. A. B. Andhare	Manufacturing
5	Dr. Y. M. Puri	Manufacturing and Industrial Engineering
6	Dr. J. G. Suryawanshi	Thermal Engineering
7	Dr. S. S. Chiddarwar	Manufacturing and Design Engineering
8	Dr. R. V. Uddanwadikar	Design Engineering
9	Dr. D. B. Zodpe	Thermal Engineering
10	Dr. A. S. Dhoble	Thermal Engineering
11	Dr. H.P. Jawale	Design Engineering
12	Dr. M. S. Kotambkar	Design Engineering
13	Dr. A. K. Singh	Design and Thermal Engineering
14	Dr. Trushar B Gohil	Thermal Engineering
15	Dr. T. V. K. Gupta	Manufacturing
16	Dr. Ravikumar Dumpala	Manufacturing
17	Dr. D. A. Jolhe	Industrial Engineering
18	Dr. A. A. Thakre	Design and Industrial Engineering
19	Dr. G. Tiwari	Design Engineering
20	Dr. K. M. Asthankar	Industrial Engineering
21	Dr. N. K. Lautre	Industrial Engineering
22	Dr. P. V. Kane	Industrial Engineering
23	Dr. P. D. Sawarkar	Thermal Engineering
24	Dr. V. M. Nistane	Design Engineering
25	Dr. S Roga	Thermal Engineering
26	Dr. Rahul Tarodiya	Thermal Engineering
27	Dr. A. A. Baxy	Design Engineering
28	Dr. N. A. Reddy	Design Engineering
29	Dr. R. P. Soni	Thermal Engineering

UG/ PG Programmes Offered by Mechanical Department:

The department offers following undergraduate and postgraduate programmes

	Program	Description
UG	B. Tech in Mechanical Engineering	Intake: 115
PG	M. Tech. in 1. Computer Aided Design & Manufacturing 2. Production & Industrial Engineering 3. Heat Power Engineering 4. Biomedical Engineering (Interdisciplinary)	 Intake : 23 Intake : 23 Intake : 23 Intake : 14

Credit System at VNIT:

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance / progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation. A student's performance/progress is measured by the number of credits he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum number of credits and a minimum grade point average must be acquired by a student in order to qualify for the degree.

Course credits assignment

Each course, except a few special courses, has certain number of credits assigned to it depending on lecture, tutorial and laboratory contact hours in a week.

For Lectures and Tutorials: One lecture hour per week per semester is assigned one credit and For Practical/ Laboratory/ Studio: One hour per week per semester is assigned half credit.

Example: Course XXXXXX with (3-0-2) as (L-T-P) structure, i.e. 3 hr Lectures + 0 hr Tutorial + 2 hr Practical per week, will have (3x1 + 0x1 + 2x0.5 =) 4 credits.

Grading System

The grading reflects a student's own proficiency in the course. While relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is based on fitting performance of the class to some statistical distribution. The course coordinator and

associated faculty members for a course formulate appropriate procedure to award grades. These grades are reflective of the student's performance vis-à-vis instructor's expectation. If a student is declared pass in a subject, then he/she gets the credits associated with that subject.

Depending on marks scored in a subject, a student is given a Grade. Each grade has got certain grade points as follows:

Grade	Grade points	Description
AA	10	Outstanding
AB	9	Excellent
BB	8	Very good
BC	7	Good
CC	6	Average
CD	5	Below average
DD	4	Marginal (Pass Grade)
FF	0	Poor (Fail) /Unsatisfactory / Absence from end-sem exam
NP	-	Audit pass
NF	-	Audit fail
SS	-	Satisfactory performance in zero credit core course
ZZ	-	Unsatisfactory performance in zero credit core course
W	-	Insufficient attendance

Performance Evaluation

The performance of a student is evaluated in terms of two indices, viz, the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. CGPA is rounded up to second decimal.

The Earned Credits (ECR) are defined as the sum of course credits for courses in which students have been awarded grades between AA to DD. Grades obtained in the audit courses are not counted for computation of grade point average.

Earned Grade Points in a semester (EGP) = **Σ** (Course credits x Grade point) for courses in which AA- DD grade has been obtained

SGPA = EGP / Σ (Course credits) for courses registered in a semester in which AA- FF grades are awarded

CGPA= EGP / Σ(Course credits) for courses passed in all completed semesters in which AA-DD grades are awarded

Overall Credits Requirement for Award of Degree of M.Tech in Production & Industrial Engineering

SN	Category of Course	Symbol	Credit Requirement
			M. Tech. (Production & Industrial Engg.) (2 Year)
	Program Core		
1	Departmental core	DC	**34**
	Program Elective		
2	Departmental Elective	DE	**18 (+1)**
Total requirement : DC+ DE =			**52 (+1)**
Minimum Cumulative Grade Point Average required for the award of degree			**6.00**

Attendance Rules

1. All students must attend every class and 100% attendance is expected from the students. However, in consideration of the constraints/ unavoidable circumstances, the attendance can be relaxed by course coordinator only to the extent of not more than 25%. Every student must attend minimum of 75% of the classes actually held for that course.
2. A student with less than 75% attendance in a course during the semester, will be awarded W grade. Such a student will not be eligible to appear for the end semester and re-examination of that course. Even if such a student happens to appear for these examinations, then, answer books of such students will not be evaluated.
3. A student with W grade is not eligible to appear for end semester examination, reexamination & summer term.

Program Outcomes for M. Tech (Common to all PG programmes):

a. PO1 → An ability to independently carry out research /investigation and development work to solve practical problems.
b. PO2 → An ability to write and present a substantial technical report/document.
c. PO3 → Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

ANNEXURE -2

Department of Mechanical Engineering

List of courses for the PG Program

M. Tech. in Industrial and Production Engineering

(modified)

I. To be offered in Odd semester

S. No	Code	Title	DC/DE	Structure L-T-P	Credit	Pre-requites
1	MEL544	Materials and Logistics Management	DC	3-0-0	3	
2	MEL502	Methods Engineering and Ergonomics	DC	3-0-0	3	
3	MEP502	Methods Engineering and Ergonomics Lab	DC	0-0-2	1	
4	MEL521	Production Planning and Control	DC	3-0-0	3	
5	MEP 521	Production Planning and Control Lab	DC	0-0-2	1	
6	MED501	Project Phase I	DC		6	25 Credits
7	MEL517	Quantitative Techniques in Industrial Management	DE	3-0-0	3	
8	MEL546	Design of Experiments	DE	3-0-0	3	
9	MEL547	Advance Supply Chain Management	DE	3-0-0	3	
10	MEL548	Reliability Engineering	DE	3-0-0	3	
11	MEL553	Personal Management and Industrial Relations	DE	3-0-0	3	
12	MEL545	Smart Manufacturing and Industry 4.0	DE	3-0-0	3	
13	MEL518	Fracture Mechanics & Non Destructive Testing	DE	3-0-0	3	

Chairman BoS
Name & Signature
(To sign on every page of the document)

II. To be offered in Even semester

S. No	Code	Title	DC/DE	Structure L-T-P	Credit	Pre-requites
1	MEL549	Industrial Automation	DC	3-0-0	3	
2	MEP549	Industrial Automation Lab	DC	0-0-2	1	
3	MEL501	Statistics and Quality Assurance	DC	3-0-0	3	
4	MEL550	Advanced Manufacturing Processes	DC	3-0-0	3	
5	MEP550	Advanced Manufacturing Processes Lab	DC	0-0-2	1	
6	MED502	Project Phase-II	DC		6	35 Credits+ Project Phase I
7	MEL551	Marketing Research and Data Analytics	DE	3-0-0	3	
8	MEL552	Production System Modeling and Simulation	DE	3-0-0	3	
9	MEL554	Business Analytics	DE	3-0-0	3	
10	MEL520	Non-Linear Optimization	DE	3-0-0	3	
11	MEL530	Machine Condition Monitoring	DE	3-0-0	3	
12	MEL532	Layered Manufacturing	DE	3-0-0	3	
13	MEP 532	*Layered Manufacturing Lab*	DE	0-0-2	1	
14	MEL555	Project Evaluation and Management	DE	3-0-0	3	
15	MEL529	Industrial Product Development	DE	3-0-0	3	
16	MEL556	Plastic Process Engineering	DE	3-0-0	3	

III. Total credits to be earned for completion of the degree program:

a) Through DC category courses = 34 credits

b) Through DE category courses = 18 credits +1

Total = 52 Credits +1

Date:

Chairman BoS
Name & Signature
(To sign on every page of the document)

ODD SEMESTER

Course Title (Code):	**Materials and Logistics Management (MEL544)**	L: 3 T: 0 P: 0
Course Objectives:	1. To know importance of integrated material management 2. To know different inventory models and inventory control technique 3. To know and improve material management functions involved in materials management and logistics 4. To give introduction to different philosophies like logistics JIT, MRP, SCM etc.	

Articulation matrix:

POs → / COs ↓	a	b	c
CO1	L	H	L
CO2	H	H	H
CO3	H	M	H
CO4	H	M	M
Overall	H	M	M

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. P Gopalkrishnan & M. Sudarshan, "Materials Management", PHI learning Pvt. Ltd.
2. A. K. Chitale, R. C. Gupta, "Materials Management: Texts and Cases", PHI learning pvt ltd.
3. Tony Arnold, "Introduction to Materials Management", Pearsons

Contents

1) Materials Management, Integrated Materials Management. **[CO1]**
   Inventory Management Models, Selective Inventory Models. **[CO2]**
2) Classification and Codification of Materials, Specification in Materials Management, Standardisation and variety reduction, Management of Material Waste, Budgeting and Materials Planning, Storage and warehousing. **[CO3]**
3) Purchase : policies and procedures, Public buying, International Purchasing, Import substitution, Source Selection, Performance Rating and Development, Negotiation, Purchasing of Capital equipment's, Make or Buy Decision, Incoming Material Quality Assurance, Value analysis for material cost reduction, Evaluation of Materials Management effectiveness. **[CO3]**
4) Introduction to Logistics Systems, Logistics Requirement Identification, Logistics Networks, Single Echelon and Multi-echelon Inventory Models, Long Houl and Short Houl Freight Transports, Warehousing, Enabling Technologies, MRP**[**, MRP-II , Just in Time, Kanban. **[CO4]**
5) Logistics, Components of Logistics, Cost Analysis of Logistics. **[CO4}**

<table>
<tr><td>Course Title (Code):</td><td>Method Engineering & Ergonomics (MEL502)</td><td>L:3 T:0 P:0</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. Understanding the fundamental principles and concepts of work study with emphasize on method study and work measurement.
2. Understanding the fundamental principles and concepts of ergonomics with its applications in various domains like, product design, workplace design, system design, anthropometry, psychology, etc.
3. Developing the analytical and problem solving abilities, using appropriate tools and techniques, in the related areas through individual or group exercises.</td></tr>
<tr><td>Articulation matrix:</td><td colspan="2">
<table>
<tr><td>POs
COs</td><td>a</td><td>b</td><td>c</td></tr>
<tr><td>1</td><td>M</td><td>M</td><td>L</td></tr>
<tr><td>2</td><td>H</td><td>H</td><td>M</td></tr>
<tr><td>3</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>Overall</td><td>H</td><td>H</td><td>M</td></tr>
</table>
H: High impact
M: Medium impact
L: Low impact
</td></tr>
<tr><td colspan="2">Prerequisite/Overlap /Equivalent Course: NIL</td><td>Prerequisite Credits: NIL</td></tr>
<tr><td>Text Books
/ Reference Books</td><td colspan="2">1. Kanawaty, George (Ed.), Introduction to Work study, ILO
2. Bridger, R. S., Introduction to Ergonomics, CRC Press
3. G. Salvendy (Ed.), Handbook of Human Factors and Ergonomics, John Wiley & Sons.
4. Sanders, M. S. and McCormick, E. J., Human Factors in Engineering and Design, McGraw-Hill.</td></tr>
<tr><td colspan="3">Contents</td></tr>
<tr><td colspan="3">1. Method study (including various recording techniques), Principles of motion economy, Micromotion study, Work measurement- Stop watch time study, Work sampling, MTM, PMTS, MOST, Concepts of performance rating, allowances and learning curve. [CO1]
2. Man-machine system, Human physiology and anatomy, Human limitations, Anthropometry (including statistical treatment), Anthropometric design procedure, Behavior, perception and psychological aspects of ergonomics, Information processing, Cognitive ergonomics, Mental workload. [CO1]
3. Occupational hazards & ergonomic intervention, WSMD, Ergonomic assessments such as REBA, RULA, Single action biomechanics analysis, HAMA, Stress indexes, etc., NIOSH & OSHA guidelines, Postural and movement analysis. [CO2]
4. Environmental factors, Effect of noise, illumination, ventilation and vibrations on human performance, Thermal comfort, Heat exchange process, Acclimatization, Metabolism, Physiological costs and energy expenditure. [CO2]
5. Design of workplace and work systems, Reach envelop analysis, Applications of ergonomics in product/system development such as automotive design, Usability analysis, Design of displays and controls, Speech intelligibility and communication design, Manual material handling and its biomechanics. [CO3]
6. Digital human modelling and analysis in virtual environment using appropriate software. Case studies/mini projects in ergonomics and work study. [CO3]</td></tr>
</table>

<table>
<tr><td>Course Title (Code):</td><td>Methods Engineering and Ergonomics Lab (MEP502)</td><td>L:0 T:0 P:2</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. To demonstrate methods engineering techniques (such as method & motion study, work measurement techniques) in a laboratory setting.
2. To inculcate the critical understanding of various ergonomic design principles.
3. To demonstrate various ergonomic assessment/analysis methods with appropriate software.</td></tr>
<tr><td>Articulation matrix:</td><td colspan="2">
<table>
<tr><th>POs
COs</th><th>a</th><th>b</th><th>c</th></tr>
<tr><td>1</td><td>M</td><td>M</td><td>L</td></tr>
<tr><td>2</td><td>H</td><td>H</td><td>M</td></tr>
<tr><td>3</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>Overall</td><td>H</td><td>H</td><td>M</td></tr>
</table>
H: High impact
M: Medium impact
L: Low impact
</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="3">Contents</td></tr>
<tr><td colspan="3">Minimum 8 experiments out of the following:
1. Study of charting techniques [CO1]
2. Study of principles of motion economy [CO1]
3. Study of Therbligs [CO1]
4. Stop watch time study [CO1]
5. Work sampling study [CO1]
6. Training for performance rating [CO1]
7. Application of MTM & PMTS [CO1]
8. Application of MOST [CO1]
9. Ergonomic assessment of different types of chair/tables [CO2]
10. Response time measurement [CO2]
11. Speech intelligibility test [CO2]
12. Design of workstation [CO2]
13. Design of displays [CO2]
14. Design of controls [CO2]
15. Physiological cost of activity [CO2]
16. Rapid Upper Limb Assessment (RULA) [CO3]
17. Rapid Entire Body Assessment (REBA) [CO3]
18. Anthropometric data collection and application [CO2]
19. Ergonomic assessment methods such as OWAS, NIOSH, etc. [CO3]
20. Gait analysis techniques. [CO3]
21. Digital human modeling. [CO3]
22. Case study-based exercises on the relevant topics. [CO3]</td></tr>
</table>

Course Title (Code):	**Production Planning and Control (MEL521)**	L:3 T:0 P:0

Course Objectives:

The student, upon completion of this course, will be able to:

1. Describe and identify various components that make up manufacturing planning and control system and their interaction.
2. Develop models that are applicable for supply chain inventory management, including quantity discounts, safety stocks, and order quantity and reorder point interactions.
3. Develop algorithms that are appropriate for solving single-machine, two-machine, parallel-machines and flow shop scheduling problems.
4. Show how (i) MRP-I, MRP-II and CRPs can be developed, and (ii) lot sizing decisions can be made in a manufacturing system.
5. Identify, discuss, and implement important research topics within production planning and control.

Articulation matrix:

POs / COs	a	b	c
1	L	H	L
2	H	H	H
3	H	M	H
4	H	M	M
5	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Samuel Eilon, "Elements of Production Planning and Control", Universal Publishing Corporation, Mumbai, 2018
2. Stephen N Chapman, "The Fundamentals of Production Planning and Control", Pearson Education Inc. 2007
3. Kanishka Bedi, "Production and Operations Management", Oxford Higher Education, 3rd Edition, 2013
4. A K Gupta, J K Sharma, "Management of Systems" Macmillan Publishers India Ltd, 2012
5. K C Jain, L N Aggarwal, "Production Planning Control & Industrial Management", Khanna Publishers, 2017
6. Mikell P Groover, "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Prentice Hall, 2nd Edition, 2007

Contents

- Manufacturing Planning and Control: Material flow characteristics in manufacturing systems, Types of manufacturing systems and their associated planning and control problems, Life cycle concepts. Product selection and design, facility, location and layouts. **(CO 1, CO2)**
- Line Balancing and Group Technology: Material handling, balancing of fabrication and assembly lines, modular assembly concepts, group technology and cellular manufacturing systems. **(CO 1, CO 2)**
- CIMS & FMS: Problem of planning and control in CIMS and FMS. Aggregate production planning. Operations scheduling, MRP. Machine assignment and allocation of jobs. Sequencing

problems. Flow shops scheduling and sequencing. Simulation of job shop priority rules. Gantt charts, production control with LOB. **(CO 3, CO 4)**

- Other Approaches & Case Studies: Maintenance / replacement and repair aspects of manufacturing facilities. MAPI and other approaches. Case studies of constraints. Supply chain management. **(CO 5)**

Course Title (Code):	PRODUCTION PLANNING AND CONTROL LAB **(MEP 521)**	L:0 T:0 P:2

Course Objectives:

The student, upon completion of this course, will be able to:

1. To develop software skills to implement various PPC techniques
2. Can manage and organize Operational and Sequential Route Sheets
3. Work on various Material Requirement Planning and Master Production Schedules through Opensource software
4. Control and evaluate different forms and methods used in computer controlled PPC
5. Can develop a new custom based techniques with combination of available methods.

Articulation matrix:

POs / COs	a	b	c
1	L	H	H
2	H	H	H
3	H	M	H
4	H	M	M
5	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

Contents

List of Experiments (Tentative):

1. Exercise based on Sales Forecasting problem using Software (Siemens CoE).
2. Evaluation of Operation and Route Sheets
3. Development of Sequential Gantt Chart (Siemens CoE)
4. Working on the MPS for a product using Software for a given Bill of Materials
5. Study of Material Handling System in a manufacturing organization (Siemens CoE)
6. Production Cost study based on Break Even Analysis

<table>
<tr><td>Course Title (Code):</td><td>PROJECT PHASE I (MED501)</td><td>L:0 T:0 P:0</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. To identify research problem
2. To review literature
3. To present research report
4. To carry out scientific investigation</td></tr>
<tr><td>Articulation matrix:</td><td colspan="2">
<table>
<tr><th>POs → COs ↓</th><th>PO1</th><th>PO2</th><th>PO3</th></tr>
<tr><td>CO1</td><td>L</td><td>M</td><td>M</td></tr>
<tr><td>CO2</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>Overall</td><td>H</td><td>H</td><td>H</td></tr>
</table>
H: High impact
M: Medium impact
L: Low impact
</td></tr>
<tr><td colspan="2">Prerequisite/Overlap /Equivalent Course: NIL</td><td>Prerequisite Credits: 25</td></tr>
</table>

Course Title (Code)	**Quantitative Techniques in Industrial Management (MEL517)**	L:3 T:0 P:0

Course Objectives:

1. Understand and learn basics of quantitative techniques and advance LPP techniques.
2. To understand and apply various Project Resource Management techniques.
3. Apply the simulation and investment analysis techniques for problem solving and decision making in the industrial and production management scenario.

Articulation matrix:

POs / COs	a	b	c
1	H	M	H
2	H	M	H
3	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Frederick Hillier, Gerald Lieberman; Introduction To Operations Research: Concepts And Cases, Mc. Graw Hill
2. David R. Anderson, et. al.; Quantitative methods for Business, South Western Cengage Learning, 12th Ed
3. N D Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 3rd Edition.
4. Rao, S. S., "Engineering Optimization (Theory and Practice)", John Wiley & Sons,
5. Taha, H. A., "Operations Research", Prentice Hall of India, New Delhi, 9th Edition

Contents

1. **Introduction: [CO1]**
   Problem solving and decision-making tools.
   Quantitative analysis and decision-making techniques.
   Quantitative Methods in Practice
2. **Extension of Linear Programming: [CO1]**
   Duality theory, primal-dual relationships, sensitivity analysis**,**
   Goal programming
   Integer programming: Pure integer, mixed integer, binary integer programming
   Problem solving by Excel Solver
3. **Project Resource Management: [CO2]**
   Allocation, Levelling and Smoothing methods, Scheduling and controlling project costs.
4. **Simulation: [CO3]**
   types of simulation – Monte Carlo simulation – simulation applications; Financial risk analysis, forecasting, inventory analysis, queueing systems analysis, misc. appl.
5. **Investment and Break-Even Analysis: [CO3]**
   Time value of money, Investment analysis,
   Risk and capital budgeting,
   B-E analysis

Course Title (Code):	**Design of Experiments (MEL546)**	L:3 T:0 P:0

Course Objectives:

1. To develop the fundamental understanding of design of experiments and other experimental designs.
2. To validated the suitability of the treated models treated for different experimental situations.
3. To present the planning, implementation and analysis of a conducted experiment.
4. To describe the purpose of robust construction in experimental design.

Prerequisite/Overlap /Equivalent Course: NIL — Prerequisite Credits: NIL

Articulation matrix:

POs / COs	A	b	c
1	H	H	H
2	H	H	H
3	H	H	H
4	H	H	H
Overall	H	H	H

H: High impact
M: Medium impact
L: Low impact

Text Books (1 to 9)/

Reference book (10)

1) Jones, B., Goos, P. (2011). Optimal Design of Experiments: A Case Study Approach. United Kingdom: Wiley.
2) Montgomery, D. C. (2008). Design and Analysis of Experiments. Singapore: Wiley.
3) Atkinson, A., Donev, A., Tobias, R. (2007). Optimum experimental designs, with SAS. United Kingdom: OUP Oxford
4) Fedorov, V. (2013). Theory of Optimal Experiments. United States: Elsevier Science.
5) Pukelsheim, F. (2006). Optimal Design of Experiments. Switzerland: Society for Industrial and Applied Mathematics.
6) Logothetis, N., Wynn, H. P. (1994). Quality Through Design: Experimental Design, Off-line Quality Control, and Taguchi's Contributions. United Kingdom: Clarendon Press.
7) Fedorov, V. (2013). Theory Of Optimal Experiments. United States: Elsevier Science.
8) Myers, R. H., Montgomery, D. C., Anderson-Cook, C. M. (2009). Response Surface Methodology: Process and Product Optimization Using Designed Experiments. Italy: Wiley.
9) Shahabudeen, P., Krishnaiah, K. (2012). Applied Design of Experiments and Taguchi Methods. India: PHI learning.
10) Handbook of Design and Analysis of Experiments Author **:**Angela Dean, Derek Bingham, John Stufken, Max Morris Publisher**:** CRC Press, UK, 2015

Content

1. **Introduction to DOE:** Basic Principles of DOE, history of DOE, Factorial Designs with Several Factors, Other Methods for analyzing Unpredicted Factorials, Outliers, 2^k design and design optimality, addition of center Points to a 2^k Design, 2^(k-p) Fractional Factorial Design, Alias Structures in Fractional Factorials, Resolution III Designs, Plackett-Burman Designs, Resolution IV and V Designs. (CO1)
2. **Blocking and confounding:** Blocking a Replicated Design, Confounding in Blocks, D Blocking Principle, , Hypothesis Testing on variances, Pooled and paired t-test, Two-sample t-test, Analysis of Variance (ANOVA), models for the Data, Post-ANOVA Comparison of Means, Sample Size Determination, Estimates of the Effects, Extension of the ANOVA to the RCBD, Residual Analysis, Latin Square Design. (CO1, CO2)

3. **Screening Experiments:** Main-effects models, two-factor interaction effects, Factor scaling, Ordinary least squares estimation, statistical power calculations, Variance inflation, Aliasing, optimal experimental designs, sparsity, hierarchy, and heredity. Follow-up design, design construction algorithm, Foldover designs. Mixture experiments, block effects, covariates, split plot design. (CO3)
4. **Response Surface Design:** Quadratic effects, Dummy variables for multilevel categorical factors, D-efficiencies, Fraction of Design Space plots, average relative variance of prediction, I-efficiencies, validity of inference based on ordinary least squares, Design regions, Cubic factor effects, Lack-of-fit test, factor constraints in the design construction algorithm, generalized least squares estimation, estimation of variance components, significance tests, optimal design of blocked experiments, orthogonal blocking. (C03)
5. **Robust parameter Design:** Robustness Concept, Analysis of the Crossed Array Design, Combined Array Designs and the Response Model Approach, Basics of Variation, small sample sizes, inability to obtain random samples, distributions (Normal, Lognormal, and Weibull), Process Capability, Process capability indices, Statistical bias in a non-linear system, Modeling output variation, Model and Optimize Multiple Outputs, Cost to the Design Model and various case studies. (CO3, C04)

<table>
<tr><td>Course Title (Code):</td><td colspan="2">Advance Supply Chain Management (MEL547) L:3 T:0 P:0</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. Select and apply scientific methods and theories for collection and analysis of quantitative and qualitative data for description
2. Complex analysis of internal and external conditions of the firm as well as theoretical issues related to these areas.
3. Set up new models of analysis and solutions for problems based on the performed analyses.
4. To communicate knowledge and discuss professional and scientific issues with colleagues, management, and the surrounding society</td></tr>
<tr><td>Articulation matrix:</td><td colspan="2">
<table>
<tr><th>POs → COs ↓</th><th>PO1</th><th>PO2</th><th>PO3</th></tr>
<tr><td>CO1</td><td>L</td><td>M</td><td>M</td></tr>
<tr><td>CO2</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>Overall</td><td>H</td><td>H</td><td>H</td></tr>
</table>
H: High impact
M: Medium impact
L: Low impact
</td></tr>
<tr><td colspan="2">Prerequisite/Overlap /Equivalent Course: NIL</td><td>Prerequisite Credits: NIL</td></tr>
<tr><td>Text Books / Reference Books</td><td colspan="2">1. Sunil Chopra and Peter Meindl , “Supply Chain Management”, Pearson – Prentice Hall publication. Ist and IInd edition
2. Janat Shah, “Supply Chain Management”, Pearson education Publication, Ist edition.
3. Spigel M.R , “Probability and statistics”, McGraw Hill Book Co, 1980</td></tr>
<tr><td colspan="3">Contents</td></tr>
<tr><td colspan="3">Understanding the supply chain, its performance, drivers and its metrics.

Logistics network configuration, Inventory Management, Financial Management, IT for supply chain Management, Risk and revenue management, Marketing and organization of supply chain. (CO1)

Global Supply Chain, Global Distribution Management & Warehousing, Managing complexities in Global Supply Chain, Supply Chain Coordination, International Trade Operations, Global Trade Agreements & Norms, Supply Chain Digitisation. (CO2)

Technology adoption in Supply Chain Management, Supply Chain Analytics, Managing disruptions in Supply Chain, Sustainability in Supply Chain, Ethics and Trust in Supply Chain, Resilience and Responsiveness in Supply Chain (CO3)

National and International case studies in a supply chain (CO4)</td></tr>
</table>

Course Title (Code):	**Reliability Engineering (MEL548)**	L:3 T:0 P:0

Course Objectives:

1. To make student able identify the failure distribution and reliability of component.
2. To make students to able to design component for reliability.
3. To make students to carry reliability testing and warranty analysis.

Course Outcome:

Students successfully completing this course should be able :

1. To understand importance of reliability Engineering
2. To evaluate component and system reliability.
3. To design mechanical component for the reliability.
4. To carry maintainability, availability and warranty analysis.

Articulation matrix:

POs → / COs ↓	a	b	c
CO1	H	H	M
CO2	H	M	M
CO3	H	M	H
Overall	H	M	M

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. C.E. Ebling, An introduction to reliability and maintainability engineering, Tata McGraw Hill Publishing Company Limited, New Delhi (1997)
2. L.S. Srinath , "Reliability Engineering", Affilated East-West Press , 4th Edition 2005
3. S.S.Rao, "Reliability engineering". Prentice Hall Press, 2014.

Contents

Introduction: Uncertainty in Engineering, Definition, Importance, Patterns of Failure, Factor of safety and reliability, reliability analysis procedure, Reliability Management.[CO1]

Basic Reliability Models: Constant Failure Rate Model, Time Dependent Failure Models, Data Collection and identifying failure and repair distribution, System Reliability Evaluation-Series, Parallel, Combined and Mixed configurations; State Dependent Models-Markov Analysis, Load-sharing system, Standby system.[CO1]

Design for Reliability: Physical Reliability models-Covariate model, Static Model, Dynamic Model, Physics - to-failure model; Reliability specifications and system measurement, Reliability Allocation, Design methods-Modeling of material strength, Fatigue strength, modeling of loads; Design of Mechanical component and system, Monte Carlo Simulation for computation of reliability.[CO2]

Reliability Testing : Accelerated Life Testing, Sequential Life Testing, Statistical Inference and Parameter estimation, Plotting of reliability data.[CO3]

Maintainability and Availability : Preventive Maintenance, MTTR, Repair Time distributions, Availability Analysis.[CO3]

Warranty Analysis : Types of warranties, Warranty cost based on a Single failure during the warranty period, warranty cost considering the time value of money -FRW Policy, PRW policy

Course Title (Code):	**Personnel Management and Industrial Relations (MEL553)**	L:3 T:0 P:0

Course Objectives:

1. Student can answer/solve questions/quizzes/case studies on personal management.
2. Student can answer/solve questions/quizzes/case studies on labour legislation.
3. Student can discuss on Human behaviour.

Articulation matrix:

POs → / COs ↓	a	b	c
CO1	H	H	H
CO2	H	H	H
CO3	M	H	M
Overall	H	H	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Knouse S.B., "Human Resources Management Perspectives", ASQC Quality Press, 1996
2. Schuler R.S. "Managing Human Resources", 4th Ed., West Publishing Co.,1992
3. Venkat Tatnam C. S., Dhal Manoranjan "Industrial Relations", second edition, Oxford University Press, 2017.

Contents

1. Human behaviour: Human behaviour of an individual as a member as a small group and as a member of an organization, Influence of culture organizational, social, national and international on individual. [CO3]
2. Personnel management: Scope and objectives of personnel management, personnel planning, recruitment and selection, training and development, wages and salary administration, incentive plans, trade unions and collective bargaining, labour welfare.[CO1]
3. Job evaluation: Job evaluation, merit rating, employee health, security and welfare, morale and motivation, leadership, organization, industrial disputes, voluntary and compulsory settlement.[CO1]
4. Labour legislations.[CO2]
5. Performance appraisal and evaluation[CO1,CO2]

Course Title (Code):	**Smart Manufacturing and Industry 4.0 (MEL545)**	L:3 T:0 P:0

Course Objectives:

1. Understanding the fundamental principles and concepts in smart manufacturing.
2. Understanding the basic principles and core technologies involved in Industry 4.0 with a special emphasis on manufacturing
3. Developing the acumen for decision making and implementation of smart manufacturing.

Articulation matrix:

POs / COs	A	B	C
1	M	M	L
2	H	H	H
3	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL

Prerequisite Credits: NIL

Text Books / Reference Books

1. Soroush, M., Baldea, M., Edgar, T. F. (2020). Smart Manufacturing Concepts and Methods. Elsevier Science
2. Gilchrist, Alasdair (2016). Industry 4.0 The Industrial Internet of Things, Apress.
3. Tao, Fei et al. (2019). Digital Twin Driven Smart Manufacturing, Elsevier
4. Alur, Rajeev (2015). Principles of Cyber-Physical Systems, The MIT Press Cambridge.

Contents

1. **Smart manufacturing paradigm:** Introduction to smart manufacturing, Principal concepts in smart manufacturing, Strategies & execution of smart manufacturing. Data centric view, Building blocks of smart manufacturing, PLM in smart manufacturing, Advanced process modelling, Analytics for smart manufacturing, Parametric optimization and control (PAROC), Decision support framework for smart manufacturing, Lean production system, Manufacturing system simulation (process & plant simulation). [CO1]
2. **Understanding Industry 4.0:** Genesis of I4.0, Digital value chain, Basic concepts & founding principles of I4.0, System integration, Drivers & barriers, Key technologies involved, Skills required, Industry 4.0 worldwide, India's readiness. [CO2]
3. **I4.0 in smart manufacturing:** Understanding Cyber-Physical Systems, Digital twins, Asset administration shell, IoT: Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs, physical devices (such as Raspberry Pi, Arduino, pcDuino, Beaglebone black, Cubieboard, etc.) [CO2]
4. **Megatrends & Communication in smart manufacturing:** Digitization & digitalization, 3D printing, Artificial intelligence, Machine Learning, Collaborative robots, Augmented / virtual reality, Sensor technology & data communication, Connected network, M2M communication, M2H communication, Communication protocols, Bluetooth, RFID, LoRaWAN, Xbee, ZigBee, etc., Cybersecurity. [CO2]
5. **Decision making in smart manufacturing:** Big data, Realtime analytics, Cloud computing, Business process management, Process identification framework, Key performance indicators, Dashboards. [CO3]
6. **Implementation framework:** I4.0 ecosystem, Strategic perspective of I4.0, RAMI 4.0, Readiness measurement: IMPULSE model, Pilot project and scaling up. [CO3]
7. Case studies/ Mini projects/ Group or individual exercises in smart manufacturing & I4.0. [CO3]

Course Title (Code):	**Fracture Mechanics & Non Destructive Testing (MEL518)**	L:3 T:0 P:0

Course Objectives:	1. Student will have knowledge of basic crack growth mechanism. 2. Student will select proper design based on fracture mechanics. 3. Student will be able to estimate the safe life design product. 4. Students will be able to get the knowledge of different NDT testing.

Articulation matrix:

POs / COs	a	B	c
1	H	H	M
2	M	H	H
3	M	H	H
4	H	H	M
Overall	H	H	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. P.Kumar, "Elements of Fracture Mechanics", McGraw Hill, 2012.
2. M. Jansen, J. Zuidema, R. Wanhill, " Fracture Mechanics" Spon Press, 2004.
3. T.L. Anderson, "Fracture Mechanics:- Fundamentals and Application", Taylor and Francis, 2005.
4. R.W. Hetzberg, " Deformation and fracture mechanics of engineering material", John wiley and son, 1996.

Contents

Introduction to fatigue and fracture mechanics, ductile and brittle fractures. Linear elastic fracture mechanics (LEFM) and Elasto plastic fracture mechanics (EPFM) approach. Crack propagation energy release rate, Fracture behaviour, stress intensity factor: **CO1 and CO2**

Fracture mechanism, Failure modes Mechanism of fatigue crack initiation and propagation. Fatigue data representation, life prediction, prevention of fatigue failures, corrosion fatigue, The pattern of stress and deformation near the tip of the crack. Determination of fracture toughness, condition for the fracture: **CO1, CO2 and CO3**

Paris equation. Fatigue and fracture safe designs. Investigation and analysis of failures: **CO1, CO2 and CO3**

Principles of various NDT techniques, Equipment, methodology, applications and benefits of various NDT techniques such as Visual inspection and eddy current testing, Liquid penetrant testing, Magnetic particle testing, Radiographic testing and Ultrasonic testing: **CO3 and CO4**

EVEN SEMESTER

Course Title (Code):	**Industrial Automation (MEL549)**	L:3 T:0 P:0
Course Objectives:	**1.** Demonstrate an understanding and awareness of concepts of industrial automation and its building blocks **2.** Inculcate the critical understanding of various industrial automation control systems working, programing and design. **3.** Recommend and implement the automation techniques to the various quality control systems.	

Articulation matrix:

POs / COs	a	b	c
1	H	M	H
2	H	M	H
3	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Frank Lamb, Industrial Automation Hands-On, Mc Graw Hill, 1st edition.
2. Morris A. Cohen, U A Apte, MANUFACTURING AUTOMATION, Richard d Irwin; 1st edition.
3. Groover M.P , "Automation, production System & CIMS", Prentice Hall of India, 4th Ed.
4. William Bolton, Mechatronics, Electronic control systems in mechanical and electrical engineering, Pearson Education Limited, Sixth Edition.
5. Koren Yoram, "Computer Control of Manufacturing Systems", Mc Graw Hill, 3rd Ed, 1986

Contents

Introduction to Industrial Automation: [C01]

Need and benefits of Industrial Automation, Automation Hierarchy and basic components
Types of Industrial Automation Systems: PLC, HMI, SCADA, CNC.
Process Industries and discrete industries automation

Building blocks of Industrial Automation system: [CO1]

Actuators, electrical drives, sensors, ADC, DAC, IO module

Discrete control systems: PLC: [CO2]

PLC components, PLC operating cycle, Logic control, sequence control,
Programming the PLC, Ladder logic diagram,
PLC based applications: Tank level control, Motor sequence control, Conveyor systems, etc.
Programable automation controllers

SCADA: [CO2]

Introduction to SCADA, SCADA architecture blocks, Editors of SCADA, SCADA-PLC interface

Computer Numerical Control: [CO2]

Numerical Control, Numerical Control Elements, Analysis of Positioning Systems
CNC Hardware Basics, Structure of CNC Machine Tools.
NC Part Programming

Automated Quality Control Systems: [CO3]

Automated inspection and testing, Contact Inspection techniques
Non-contact inspection techniques.

<table>
<tr><td>Course Title (Code):</td><td colspan="2">Industrial Automation Lab (MEP549)</td><td>L:0 T:0 P:2</td></tr>
<tr><td>Course Objectives:</td><td colspan="3">1. Demonstrate an understanding and awareness of concepts of automation.
2. Inculcate the critical understanding and programming of PLC and CNC systems.
3. Recommend and implement the automation techniques to the various practical situations.</td></tr>
<tr><td>Articulation matrix:</td><td colspan="3"><table><tr><th>POs
COs</th><th>a</th><th>b</th><th>c</th></tr><tr><td>1</td><td>H</td><td>H</td><td>H</td></tr><tr><td>2</td><td>H</td><td>H</td><td>H</td></tr><tr><td>3</td><td>H</td><td>H</td><td>H</td></tr><tr><td>Overall</td><td>H</td><td>H</td><td>H</td></tr></table>H: High impact
M: Medium impact
L: Low impact</td></tr>
<tr><td colspan="3">Prerequisite/Overlap /Equivalent Course: NIL</td><td>Prerequisite Credits: NIL</td></tr>
<tr><td>Text Books
/ Reference Books</td><td colspan="3">1. Frank Lamb, Industrial Automation Hands-On, Mc Graw Hill, 1st edition.
2. Morris A. Cohen, U A Apte, MANUFACTURING AUTOMATION, Richard d Irwin; 1st edition.
3. P N Rao, CAD/CAM: PRINCIPLES AND APPLICATIONS, Tata McGraw Hill Education Private Limited, 3rd Edition.
4. Koren Yoram, “Computer Control of Manufacturing Systems”, Mc Graw Hill, 3rd Ed, 1986
5. Machine manuals of CNC VMC, WEDM, EDM, CMM.</td></tr>
<tr><td colspan="4">Contents</td></tr>
<tr><td colspan="4">1. Performance, demonstration on CNC VMC (at least two Complex Geometries) [CO1]
2. Performance, demonstration on CNC WEDM (at least two Complex Geometries) [CO1]
3. Performance, demonstration on CNC CMM (at least two Complex Geometries) [CO1]
4. Performance, demonstration on CNC EDM [CO1]
5. PLC demo and programming [CO2]
6. Practice Programming on Manual Part Program[CO2]
7. SCADA system study and demo [CO1]
8. Case Study on Automated System of any Industry[CO3]</td></tr>
</table>

Course Title (Code):	**Statistics And Quality Assurance (MEL501)**	L:3 T:0 P:0

Course Objectives:

1. Understand the applications of Probability distribution in predicting behavior of the process.
2. Develop conceptual understanding of Quality of Product and Process and its Management.
3. Develop Control charts for process control.
4. Develop understanding of sampling plans for acceptance of materials.

Articulation matrix:

POs / COs	a	b	c
1	M	M	L
2	H	H	H
3	H	M	H
4	H	H	H
Overall	H	H	M

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Spigel M.R , "Probability and statistics", McGraw Hill Book Co, 1980
2. Gupta, Kapoor ,"Fundamentals of Mathematical Statistics", S.Chand& Sons, 8th Ed, 1998
3. Duncan A.J., Irwin Richard D., "Quality Control and Industrial Statistics", INC, USA, 1965
4. Feigenbaum F.V, "Total Quality Control", McGraw Hill International Edition, 3rd Ed, 1987
5. Halpern S., "The Assurance Sciences", Prentice Hall India Ltd.New Delhi, 1979

Contents

1. Statistics: Probability theory, Random variables (discrete &continuous), binomials, poisons, normal and other standard distribution. Chebychev's inequality, joint distribution, moment generation function, measure of control tendency, variability, control limit theorem, sampling theory and distribution, estimation theory. Hypothesis testing, x2 goodness fit curves, Regression analysis. (CO1)
2. Quality Assurance: Concept of quality characteristics, Value of quality, Quality of design and conformance, Process capability, selective assembly, concept in total quality control and quality system, Quality assurances. (CO2)
3. SQC: Quality cost aspects. Job plan. Case study in value analysis. Process control - Concept of S.Q.C. control chart for variable additives and attributes. Multi-characteristics control chart. Acceptance sampling plan, single, Double and sequential sampling, ACL, LTPD concept. AOQL and rectification plan. Economic of inspection. Motivation for quality assurance. TQM:Total quality management, Zero-defect program, Quality circle. (CO3, CO4)

Course Title (Code):	**Advanced Manufacturing Processes (MEL550)**	L:3 T:0 P:0

Course Objectives:

The student, upon completion of this course, will be able to:

1. Enrich knowledge of various manufacturing processes with emphasis on fundamental principles and methods in various advanced manufacturing processes.
2. Analytical concepts of different manufacturing processes
3. Analyze and interpret the effect of various parameters in each of the process.
4. Build a strong foundation for solving, analysis and synthesis of both conventional and unconventional manufacturing processes.

Articulation matrix:

POs / COs	**a**	**b**	**c**
1	L	H	M
2	H	H	H
3	H	M	H
4	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books

1. G.F. Benedict, Non-traditional Manu. Processes, Marcel Dekker, Inc. New York, 1987.
2. V.K. Jain, Advanced Machining Processes, Allied Publishers, 2002.
3. A. Ghosh, A.K. Mallik, Manufacturing Science, East-West Press Ltd, New Delhi, 1985.
4. John Norrish, Advanced Welding Processes, Woodhead Publishing

Reference Books

1. P.C. Pandey, and H.S. Shan, Modern Machining Processes, Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 1980.
2. J.A. McGeough, Adv. Methods of Machining, Chapman and Hall, London, 1988.
3. Amitabh Bhattacharya, Metal Cutting Theory & Practice
4. Sen & Bhattacharya, Metal Cutting Theory and Cutting Tool Design
5. Boothroyd, G and Knight, W A., Fundamentals of Machining and Machine Tools, 3rd Third Edition, Saint Luice Pr, 2005.
6. E J A Armerago, R H Brown, Machining of Metals, Prentice Hall

Contents

1. SMART Foundry: Concepts of modern foundry (CAD, 3D Pattern Making, Gating System Design, Mould Filling Analysis, Automatic Moulding, Melting and Solidification. **(CO1)**
2. Modelling of metal cutting & grinding processes: Review of cutting mechanism; Cutting force model; Oblique Cutting; Temperature analysis (Finite Difference Method); Wear model. Modelling of grinding process, Grinding force model, Temperature analysis, Wheel life model. Introduction to finishing processes like Honing, Lapping, Super finishing, etc. **(CO1, CO2)**
3. Unconventional Machining Processes: Electric Discharge Machining (EDM); Electron Beam Machining (EBM); Plasma Arc Machining (PAM); Laser Beam Machining (LBM); Ultrasonic Machining (USM); Abrasive Jet Machining (AJM); Water Jet Cutting (WJC),

Abrasive Water Jet Machining (AWJM); Electro-Chemical Machining (ECM); Chemical Machining (CHM). **(CO3, CO4)**

4. Micro-Nano Precision Machining: Introduction to nano-precision mechanical manufacturing: M4 processes, Nano-precision cutting, Nano-precision grinding, Nano-precision polishing. **(CO4)**
5. Advanced Welding Processes: Introduction to various advanced welding processes, magnetic arc welding, friction welding, explosive welding, ultrasonic and laser welding processes. **(CO3)**

Course Title (Code):	**Advanced Manufacturing Processes Lab (MEP550)**	L:0 T:0 P:2

Course Objectives:

The laboratory course aims at:

1. Hands on working with CNC machines and on various modern manufacturing methods.
2. Able to analyse the significant controlled parameters for optimal performance of different manufacturing processes.
3. Understanding of different methods and materials used in manufacturing industry and for research.
4. Combination of two or more different processes for end user application

Articulation matrix:

POs / COs	**a**	**b**	**c**
1	L	H	M
2	H	H	H
3	H	M	H
4	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

Contents

1. To develop a part using different tools in smart casting and analyse for shrinkage and other defects.
2. To acquire and analyse the cutting force data in oblique cutting of any metal on a CNC milling with dynamometer.
3. To machine a component on CNC turning and evaluate its dimensions and surface roughness.
4. To fabricate a part using EDM and analyze the dimensional characteristics using Optical Microscope
5. To use Wire EDM process for cutting a profile on MS plate.
6. To make 2D profile cut on SS plate with AWJM.
7. To deposit an alloy with advanced welding torch and study the characteristics.
8. To generate a part using laser cutting process.
9. To generate a part using laser cutting process.

<table>
<tr><td>Course Title (Code):</td><td>PROJECT PHASE II (MED502)</td><td>L:0 T:0 P:0</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. To identify research problem
2. To review literature
3. To present research report
4. To carry out scientific investigation</td></tr>
<tr><td>Articulation matrix:</td><td colspan="2">
<table>
<tr><th>POs → COs ↓</th><th>PO1</th><th>PO2</th><th>PO3</th></tr>
<tr><td>CO1</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO2</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO3</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>CO4</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>Overall</td><td>H</td><td>H</td><td>H</td></tr>
</table>
H: High impact
M: Medium impact
L: Low impact
</td></tr>
<tr><td colspan="2">Prerequisite: Project phase I (MED501)</td><td>Prerequisite Credits: 35</td></tr>
</table>

Course Title (Code):	**Marketing Research & Data Analytics (MEL551)**	L:3 T:0 P:0

Course Objectives:

1. Understanding the fundamental principles and concepts of marketing along with marketing mix variables.
2. Developing the analytical and decision-making skill to deals with various aspects of marketing.
3. Developing the aptitude for real life problem solving in marketing research through case studies or appropriate exercises.

Articulation matrix:

POs / COs	a	b	c
1	M	M	L
2	H	H	H
3	H	H	M
Overall	H	H	M

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Kotler, Philip and Keller, Kevin (2012). Marketing Management, Prentice-Hall.
2. Cant, M. C., Strydom, J. W, Jooste, C. J., du Plessis P. J. (2006). Marketing Management, Juta Legal & Academic Publishers.
3. Saxena, Rajan (2009). Marketing Management, Tata McGraw-Hill.
4. Nelli, Fabio (2018). Python Data Analytics, Apress

Contents

1. Introduction to marketing; Basic marketing concepts- needs, wants, demands, values, etc.; 4Ps of marketing; Marketing environment; Segmentation; Targeting; Positioning. [CO1]
2. Concept of a product; Classification of products; Critical to customer satisfaction product attributes; Product line and product mix; Product life cycle and appropriate marketing strategies. [CO1]
3. Distribution channels; Retailing and wholesaling; Direct marketing; Personal selling; Product portfolio analysis; Product pricing; Sales promotion – tools and techniques; Advertising; Branding; Packaging. [CO2]
4. Social, ethical and legal aspects of marketing; Marketing of services; International marketing; Green marketing; Cyber marketing; Social marketing; Rural marketing; Service marketing; E-commerce and internet marketing; Customer relationship management, Competition analysis, Consumer behaviour, Marketing 4.0 [CO3]
5. Data analytics applications in marketing research, Market Basket Analysis, Cluster analysis, Factor analysis, Conjoint analysis, Demand and sales forecasting, Big data analytics, Other quantitative and qualitative techniques in marketing such as Interpretive Structural Modelling, Analytic Hierarchy Process, etc. Use of appropriate software (such as Python, R) for marketing analytics. [CO2]
6. Case studies/ individual or group exercises in various topics of marketing research. [CO3]

Course Title (Code):	**Production System Modelling & Simulation (MEL552)**	L:3 T:0 P:0

Course Objectives:

1. Understand the concepts in system modelling & simulation and underlying statistical theories.
2. Develop the appropriate model of production systems in system specific context and simulate it to understand system behaviour
3. Develop the skills of modelling and simulation using various software programming languages.

Articulation matrix:

POs / COs	a	b	c
1	M	H	L
2	H	H	M
3	H	M	H
Overall	H	H	M

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. Banks, Jerry; Carson II, John; Nelson, Barry and Nicol, David (2013). Discrete Event System Simulation, Prentice-Hall
2. Law, Averill (2007). Simulation Modelling and Analysis, Tata McGraw Hill
3. Sterman, John (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World, McGraw-Hill
4. Gilbert, Nigel (2008). Agent-based models, SAGE Publication

Contents

Systems concepts in manufacturing, Types of systems, Basic concepts in simulation, Probability and statistical distributions, Random numbers and random variates, Monte Carlo simulation [CO1], Discrete event simulation, Input and output data analysis, Variance reduction techniques, Model verification and validation, Markov chain model, Introduction to systems dynamics: casual loop diagrams, stock flow diagram, system dynamics simulation. Introduction to agent-based simulation: types of agents and applicability of agent-based simulation [CO2]. Application of simulation in manufacturing system design such as machining, assembling, material handling, queueing systems, warehousing, inventory control, scheduling, line balancing, supply chains, project management, maintenance management, traffic-flow management, plant simulation, process simulation, etc., Simulation of service systems.

System modelling and simulation using appropriate software / programming language. Case studies and mini projects in system simulation. [CO3]

Course Title (Code):	**Business Analytics (MEL554)**	L:3 T:0 P:0

Course Objectives:

1. To develop the fundamental understanding of descriptive and inferential statistics, predictive analysis, mathematics, data mining, correlation and regression.
2. To explore data blending, data extracts, and forecasting.
3. To develop an understanding on data visualization techniques using recent tools
4. To learn the prerequisite of data mining and artificial intelligence techniques.
5. To enhance the knowledge of Data Analytics with hands-on demos or projects

Articulation matrix:

POs / COs	a	b	c
1	H	H	H
2	H	H	H
3	M	H	M
4	H	H	H
5	H	H	H
Overall	H	H	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books

1) Microsoft Excel Data Analysis and Business Modeling by Wayne L. Winston
2) Naked Statistics: Stripping the Dread from the Data by Charles Wheelan
3) Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython by Wes McKinney
4) SQL in 10 Minutes a Day by Ben Forta
5) Storytelling with Data: A Data Visualization Guide for Business Professionals by Cole Nussbaumer Knaflic
6) Practical Tableau: 100 Tips, Tutorials, and Strategies from a Tableau by Ryan Sleeper
7) The Hundred-Page Machine Learning Book by Andriy Burkov
8) The Pyramid Principle: Logic in Writing and Thinking by Barbara Minto
9) Scoring Points: How Tesco Continues to Win Customer Loyalty by Terry Hunt

Reference Books

Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Author: Foster Provost and Tom Fawcett Publisher: O'Reilly Media, Inc, 1005 Gravenstein Highway North, Sebastopol, CA 95472

Contents

1) **Introduction to Statistics**
Important statistical concepts used in data science, Difference between population and sample. Types of variables, Measures of central tendency, Measures of variability, Coefficient of variance, Skewness and Kurtosis. Normal distribution, Test hypotheses,

Central limit theorem, Confidence interval, T-test, Type I and II errors, Student's T distribution, regression, ANOVA, R square, correlation and causation. (CO1)
2) **Business exploratory data analytics:** Descriptive analysis, project management methodology, Data Collection - Surveys and Design of Experiments, Data Types namely Continuous, Discrete, Categorical, Count, Qualitative, Quantitative and its identification and application, Further classification of data in terms of Nominal, Ordinal, Interval & Ratio types, Balanced versus Imbalanced datasets, Cross Sectional versus Time Series vs Panel / Longitudinal Data, Batch Processing vs Real Time Processing, Structured versus Unstructured vs Semi-Structured Data, Big and Not-Big Data, Data Cleaning / Preparation - Outlier Analysis, Missing Values Imputation Techniques, Transformations, Normalization / Standardization, Discretization, Sampling techniques for handling Balanced vs. Imbalanced Datasets, sampling funnel and its application and its components (Population, Sampling frame, Simple random sampling Sample), Microsoft analytical tools. (CO2)
3) **Business Intelligence and exploratory data analysis :** Data Wrangling and visualisation, Missing value analysis, correction matrix, outlier detection, deep diving with data and connection, creating charts, mapping data, reporting, preparing dashboards, stories and other business intelligence tool. (CO3)
4) **Machine Learning :** Basics of machines to mimic humans. neural networks (Feedforward and Backpropagation), supervised and Unsupervised learning, parametric/Non parametric learning algorithms, learning models, Naïve Bayes, principal component analysis, linear discriminant analysis, linear Regression, logistic Regression, classification & KNN, decision trees, random forest clustering – K Means & hierarchical Clustering, time series analysis, ARIMA Models, support vector machine, model validation/cross validation techniques, Parameter tuning. (CO4)
5) **Case Studies and Tools to be used** : Microsoft analytical tool (Excel), Open-source software's (Python), etc. 6) **Introduction to related developments:** Big data, NLP, Data Warehousing, Data Mining, Cloud Computing, Sentiment Analysis, analyzing Social Network Graphs, Feature Selection, etc. (CO5)

Course Title (Code):	**Non-Linear Optimization (MEL520)**	L:3 T:0 P:0

Course Objectives:

1) To present the basic theory of non linear constrained and unconstrained problems that arose in engineering.
2) To give a thorough understanding of getting solution to these problems and some experience in solving them.
3) To develop the skills for the formulation and solution of mathematical models in their own research.

Articulation matrix:

POs / COs	a	b	c
1	H	M	H
2	M	M	M
3	H	H	H
Overall	H	M	M

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1. S. S. Rao. "Engineering Optimization (Theory and Practice) " byJohn Wiley & Sons
2. Jasbir S. Arora. "Introduction to Optimum Design" Elsevier Academic Press
3. K. Deb "Optimization for Engineering Design-Algorithms and Examples" PHI Learning Private Limited, New Delhi
4. K. Srinivasa Raju and D. Nagesh Kumar" Multicriterion Analysis in Engineering and Management" PHI Learning Pvt. Ltd., New Delhi, India

Contents

1. Introduction to Optimization Techniques, Historical Development, Engineering application of Optimization, Formulation of design problems as mathematical programming problems, Classification of optimization problems, Statement of an Optimization problem, design vector, design constraints, constraint surface, objective function, objective function surfaces, classification of Optimization problems, Graphical Method. Necessary and Sufficient conditions for minimum/maximum, [CO1]
2. Lagrange multipliers.Unconstrained optimization Techniques, Direct search method, Univariate and pattern search method, Indirect search methods: Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems.[CO2,CO3]
3. Constrained Optimization Introduction, Linear Programming (Simplex), Duality and Sensitivity analysis,Sequential Linear Programming, Generalized reduced gradient method, Methods of feasible direction Indirect method, Interior and exterior penalty function. Karush-Kuhn-Tucker conditions. Application to engineering problems. [CO2,CO3]
4. Dynamic Programming, Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality, Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming (DP),Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP, Applications. [CO2,CO3]
5. **Integer Programming** Integer linear programming; Concept of cutting plane method, Mixed integer programming; Solution algorithms, Applications.Advanced Topics: Multi objective optimization- Weighted and constrained methods, Multi level Optimization, Evolutionary algorithm for optimization and search, Applications. [CO2,CO3]

Course Title (Code):	**Machine Condition Monitoring (MEL530)**	L:3 T:0 P:0

Course Objectives:

1. Know basic machine problems and their monitoring methods.
2. Use of appropriate parameter for monitoring
3. Use of modern tools for monitoring
4. Draw charts, graphs, etc. to indicate machine status

Articulation matrix:

POs → / COs ↓	PO1	PO2	PO3
1	M	L	H
2	H	L	H
3	H	M	H
4	M	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL | Prerequisite Credits: NIL

Text Books / Reference Books

1. Randall R. B., "Vibration Based Condition Monitoring," Ch.1, Ch. 2, Ch 3, Wiley, New Delhi, 2010.
2. Cempel C., "Ellis Horwood Series in Mechanical Engineering, Vibroacoustic Condition Monitoring," pp. 1 – 43, Michigan
3. Piersol A. and Paez T , "Harris' Shock and Vibration Handbook," Mc-Graw Hill, 2010
4. Alan Davies, "Handbook of Condition Monitoring: Techniques & Methodology," Chapman & Hall, London, 1998

Contents

Introduction: Definition, Need and relevance to maintenance, Different techniques and their practical applications. Vibration and AE based condition monitoring, Measurement of vibration and acoustic emission – Measuring parameters, Transducers, selection of appropriate parameters and transducers.[CO1]

Data acquisition and signal processing: A/D converters, Filters, Time & Frequency domain analysis, Analysis of stationary and non stationary signals- FFT and Wavelet Transform in machine condition monitoring. Analysis and interpretation of vibration and AE data, trending, indices for condition monitoring, their significance, normal and fault indicating values, ISO and other standards.[CO2,CO3]

Oil & wear debris analysis and ferrography: Principles, methods and instruments for wear debris analysis and ferrography. Condition monitoring of various machine components and machines like bearings, gears, pumps, compressors, turbines, machine tools, cutting tools, etc. to diagnose various defects.[CO3]

Machinery prognostics, prediction of failures, concept of integrated analysis[CO4].

Course Title (Code):	**Layered Manufacturing (MEL532)**	L:3 T:0 P:0

Course Objectives:	1 Understand the current available layered manufacturing systems, their operating principles and their characteristics 2. Be able to describe complementary, secondary fabrication processes 3. Be able to select the appropriate fabrication technology or technologies for a given task

Articulation matrix:

POs → / COs ↓	PO1	PO2	PO3
1	H	H	M
2	M	H	H
3	H	H	H
Overall	H	H	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books	1. Nasr, E.A., Kamrani, A.K., "Engineering design and Rapid prototyping", Springer **2.** Cooper, K.G., "Rapid prototyping Technology: Selection and application", CRC press

Contents

Overview of Rapid prototyping and automated fabrication technologies, Need of prototype in typical design cycle, Ideal design cycle and manufacturing, Free from fabrication for product design and manufacturing.[CO1]

Rapid prototyping technologies, History of layered manufacturing, Steriolithography, Solid ground curing, Selective laser sintering, Fused deposition modeling, Laminated object manufacturing and Other systems. [CO1]

The underlying material science, Photopolymers, Thermoplastics, Powders. [CO2]

Generating CAD models suitable for automated fabrication, The .STL file format, Repairing CAD models, Adding support structures, Model slicing . [CO2]

Rapid prototyping assisted casting, Casting simulation, Pattern making using Rapid prototyping, Die making using Rapid prototyping, Application, Remote manufacturing on demand. [CO3]

Ongoing research activities, Medical implant manufacturing. [CO3]

Course Title (Code):	**Layered Manufacturing Lab (MEP532)**	L:0 T:0 P:2

Course Objectives:	1. 3 D modelling software 2. To fabricate model of given component 3. To use simulation software

Articulation matrix:

POs → COs ↓	**PO1**	**PO2**	**PO3**
1	H	H	M
2	H	M	H
3	H	M	H
Overall	H	M	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books	1. Nasr, E.A., Kamrani, A.K., "Engineering design and Rapid prototyping", Springer **2.** Cooper, K.G., "Rapid prototyping Technology: Selection and application", CRC press

Contents

1. Study and use of 3-D modeling software to generate .STL file. [CO1]
2. Generation and repairing of .STL file for Rapid prototyping. CO1]
3. Fabrication of physical model on Rapid prototyping machine using Break-away support system.[CO2]
4. Fabrication of physical model on Rapid prototyping machine using Soluble support system. [CO2]
5. Use of simulation software for rapid prototyping assisted casting. [CO3]

<table>
<tr><td>Course Title (Code):</td><td>Project Evaluation & Management (MEL555)</td><td>L:3 T:0 P:0</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">1. Students will be able to use various tools and techniques for project management.
2. Students will be able to prepare feasibility report for a new project.</td></tr>
<tr><td>Articulation matrix:</td><td colspan="2">
<table>
<tr><th>POs → / COs ↓</th><th>a</th><th>b</th><th>c</th></tr>
<tr><td>1</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>2</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>Overall</td><td>H</td><td>H</td><td>H</td></tr>
</table>
H: High impact
M: Medium impact
L: Low impact
</td></tr>
<tr><td colspan="2">Prerequisite/Overlap /Equivalent Course: NIL</td><td>Prerequisite Credits: NIL</td></tr>
<tr><td>Text Books / Reference Books</td><td colspan="2">1. Meredith jack R., Mantel S.J., Project Management, fifth edition, Wiley, 2005.
2. Choudhary S.; Project Management, 9th Ed.; Tata McGraw hill, Mew Delhi, 2003
3. Panneerselvam R., Senthilkumar P. , Project Management, PHI, 2009.</td></tr>
<tr><td colspan="3">Contents</td></tr>
<tr><td colspan="3">
1. Introduction: [CO1]
Project Evaluation, Benefits of project evaluation, Limitation of project evaluation, Methods of project evaluation.
2. Project Management Concept: [CO1]
Concept of project management, Establishing the project: scope, time, cost and performance, Goals, Organizing human resources and contracting.
3. Project Management techniques:[CO1,CO2]
Organizing systems and Procedures for project implementation, project direction, coordination and control, project management & performance.
4. MIS: Management information system.[CO1,CO2]
</td></tr>
</table>

Course Title (Code):	**Industrial Product Development (MEL529)**	L:3 T:0 P:0

Course Objectives:	1) To explain students what is an engineering product, 2) To make student understand various definitions and theoretical concepts related to Industrial product development at PG level. 3) To explain student the product development strategies and subsequent steps to manifest conceptualized product idea into an engineering product form Industry perspective. 4) To make the students comprehend the need of organization, integration of engineering knowledge technology tools and other resources to deliver commercial engineering product. 5) To analyse commercial engineering product with above objectives through the case studies.
Articulation matrix:	

POs → / COs ↓	**a**	**b**	**c**
1	H	H	H
2	H	H	H
3	H	H	H
4	H	H	H
5	H	H	H
Overall	H	H	H

H: High impact
M: Medium impact
L: Low impact

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books	1. New product Management, Crawford and Bendetto, Irwin MCGraw Hill, 6th Edition, ISBN 978, 2010 editionRao, S. S., "Engineering Optimization (Theory and Practice)", John Wiley & Sons. 2. Product planning and Management by William l Moore and E. A. Pressemier McGraw-Hill International edition 2nd Edition, 2009 3. Engineering design methods strategies for product design, Nigel Cross, Willey Publication 4. Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill, 5th Edition, 2015 reprint

Contents

1. New Product Development

Basic Concepts in Design, Concept Level, Cost v/s Time evaluation, Necessity of new products, Organizational Strategies to handle new product Development, Management Approaches towards Engineering Design, Emergence of Engineering Product Development, Market Research, Formation of cross functional Teams, Quality Function Development, Product Brief, Business Case preparation and clearance , Budget Planning, Product Costing, Roles of respective CFT members, Stakeholders" meeting, concept gate review.

Generation -1

Building first generation aggregate and prototypes, Tooled up exclusive components few, in quantity and percentage wise, 3D Modelling of the components, Validation through CAE rout, Testing and Validations of aggregates, Field testing of prototypes for identified application, Generation 1 gate review.

3. Generation -2

Corrections form generation -1, Tooled up exclusive and prototypes and aggregate build, Capital budget outflow, pre-production approval process, manufacturing location total involvement, role of

CFT members from plant, Jury panel evaluation, Progress on validation, issue on capturing and resolution process, Virtual 3D modelling of the product through virtual assembly line, Generation 2 gate review

4. Seeding

Seeding of the product, batch size, Implementation of Quality Function Deployment, Monitoring the performance at customer end, Monitor and ensure Budget utilization, Enhanced role of customer care, Marketing, Component development, quality assurance and product development teams, Monitoring the cost v/s target, capturing the issues and resolution process, Seeding Gate review.

5. Pilot Production

Gradual ramp up in production, ramp up planning, CFT team dynamics, CFT accountability, Product strengthening in the market, Spares availability, certification of the pre-production approval process, Capturing the issues and resolution process, Stakeholders‟ clearances for production batches, Pilot production gate review.

6. Start of the volume production(SoVP)

Planning for SoVP, enhancement in the accountability of different functions, Spare parts management, Team strengthening for production success, Quality and customer care initiative, Handing over the issue resolution process, Material development function handover, Quality Assurance function handover to plant QA team, Engineering release for production, SoVP gate review. Formal Project Closure

Customer satisfaction Index, Commercial brand Marketing , Stakeholders review meeting

Course Title (Code):	Plastic Process Engineering	L:3 T:0 P:0

Course Objectives:

1. To provide the fundamental understanding on the plastics, their properties, applications, processing.
2. To learn about the processing techniques of different polymers their significance and applications in different fields
3. To plan for and manufacturing, materials, product design, mold design.
4. learn about the various finishing/machining operations required after producing plastic articles and different types of coating and printing technique suitable to plastic substrate.
5. To formulate plan for testing & quality control, and recycling.

Articulation matrix:

POs → / COs ↓	a	b	c
CO1	H	M	H
CO2	H	M	M
CO3	M	M	M
CO4	M	M	H
CO5	H	M	H
Overall	H	H	H

Prerequisite/Overlap /Equivalent Course: NIL	Prerequisite Credits: NIL

Text Books / Reference Books

1) Brydson, J. A. (1999). Plastics materials. Elsevier.
2) Morton-Jones, D. (2012). Polymer Products: design, materials and processing. Springer Science & Business Media.
3) Morrison, P. (1982). Plastics Materials and Processes.
4) O'Brien, K. T., Rao, N. S. (1998). Design Data for Plastics Engineers. Germany: Cincinnati.
5) Rao, N. S. (1991). Design Formulas for Plastics Engineers. Austria: Hanser Publishers.
6) Michaeli, W., Hopmann, C. (2017). Extrusion Dies for Plastics and Rubber: Design and Engineering Computations. Germany: Carl Hanser Verlag GmbH & Company KG.
7) Mastro, P. F. (2016). Plastics Product Design. Germany: Wiley.
8) DuBois, J. H., Levy, S. (2012). Plastics Product Design Engineering Handbook. United States: Springer US.
9) Catoen, B., Rees, H. (2021). Injection Mold Design Handbook. Germany: Hanser Publications.
10) Selke, S. E. M. (1997). Understanding plastics packaging technology. Austria: Hanser Publishers.
11) Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions. (2020). Netherlands: Elsevier Science.

Reference book: Handbook of Plastic Materials and Technology. Angela Dean, Derek Bingham, John Stufken, Max Morris, United Kingdom: Wiley, 1990.

Contents

Introduction to Plastic Materials: Sources of raw materials –Monomers –Polymers – Polymerisation - Types of Polymerisations – Classification. Definition and Classification of Plastics – General properties – Historical development of plastic industry-future trends, Thermoplastics, Thermosetting, Engineering & High performance plastics. Effect of Crystallinity on properties, Molecular weight, Glass transition temperature. Additives and compounding. (CO1)

Plastic product and mould design: Selection of appropriate material moulding and forming processes. Draft, radii, dimensional tolerances, wall thicknesses, ribs and bosses, inserts, sink marks, undercuts, feeding system, gate location, flow pattern, shrinkage and post moulding shrinkage. Design of Plastic

under static and dynamic load. Types of injection mould and its working. Split Mould and its mechanism. compression moulds, transfer moulds and blow moulds. Types of extrusion dies, Dies for Pipe and Sheet. (CO2)

Plastic Processing and Packaging : Extrusion processes, design, types, characteristic, output estimations, . Compression and Transfer moulding, FRP Laminates processing, hand lay-up, spray up method vacuum bag & pressure bag moulding, filament welding, centrifugal casting, pultrusion, matched die moulding laminates, industrial laminates, mechanical foaming, chemical foaming, physical foaming, Machinery & joining of Plastics, Joining principles cohesion Principle, adhesion principle, Casting Processes, Types of Calendering, types of Coating, Other Secondary Processes: Printing, painting, hot stamping, in mould decoration, Electro plating and vacuum metallising, decorating. Dies, Sizing and Downstream equipments, Faults. Polymeric packages scope, Forms of packages. Development and selection criteria of suitable polymeric packages, recent advances in foams. (CO3)

Rheology & Testing of polymers: Polymer rheology and measurement, Chemical Properties, role of ASTM, BS, IS Test specimen preparation in testing of polymers, Degradation behaviour of polymers. Introduction to polymer characterization by advance instrumental techniques such as IR, NMR, DSC, TGA, SEM, etc. Testing various properties of plastic like simple properties, mechanical test, thermal, permeability, flow, optical, electrical, and other properties, Product testing and designing for pipe and fittings-film and sheets, Pipe and tube, blow bottle, etc. (CO4)

Plastic Waste Management : Biodegradable plastics, Environmental issues, policies and legislations, Life cycle analysis, tests for appropriate methodology, ready biodegradability, recycling and its problems, sources of plastics waste, separation technologies, plastics recycling Classification Code of practice, waste plastics as fillers, mixed waste recycling, surface refurbishing, plastics ageing, wear and erosion. (CO5)