आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

Course Structure

&

Syllabus

Of

M. Tech
Mechanical Engineering

[Applicable w.e.f. Academic Session - 2022-23]

[As per CBCS guidelines given by UGC]

SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD.

School of Engineering & Technology ★ IFTM University, Moradabad ★
Director

Registrar
IFTM University
Moradabad.

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DEPARTMENT OF MECHANICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD.
www.iftmuniversity.ac.in

Study & Evaluation Scheme of Master of Technology (M. Tech) Mechanical Engineering

Programme:	**Master of Technology in Mechanical Engineering**
Course Level:	**PG Degree**
Duration:	**02 Years (Four semesters) Full Time**
Medium of instruction:	**English**
Minimum Required Attendance:	**75%**
Maximum credits:	**58**

Programme Outcomes (POs):

Students completing this programme will be able to:

1. Understanding of tools and techniques, and their usage in analysis and design.
2. To conduct literature surveys and contribute in emerging areas through collaborative and multidisciplinary research.
3. To understand and integrate existing and new acquired knowledge in the discipline for future enrichment.
4. Ability of creative thinking, critical analysis and decision making for productive research and development.
5. Devise feasible and optimal solutions to the problems in the area of expertise, amenable to society and environment.
6. Ability of independent and reflective learning.
7. Understanding of the professional and ethical responsibilities
8. To improve capability for solving engineering problems
9. Ability to write reports and communicate through effective presentations.
10. To impart research skills amongst the graduates with professional and ethical attitude.

Programme Specific Outcomes (PSOs):

The learning and abilities or skills that a student would have developed by the end of two-years.

1. Understanding and Analyzing the real time problems and to develop solutions by applying appropriate mathematical logic and algorithms.
2. Applying knowledge in various domains to identify research gaps and hence to provide solution to new Ideas and innovations.
3. Applying skills acquired for retrieving, analyzing and managing large data leading to effective decision making and application development using suitable engineering tools.

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Choice Based Credit System (CBCS):

Choice based credit system (CBCS), provides a learning platform wherein the student or knowledge seeker has the flexibility to choose their course from a list of elective, core and soft skill courses. This is a student-centric approach to achieve his target number of credits as specified by the UGC and adopted by our University.

Groups of CBCS:

The following is the course module designed for the M.Tech program:

8. Elementary / Fundamental Science courses (FSC)
9. Engineering Core Courses (ECC)
10. Engineering departmental Elective (EDE)
11. Dissertation/Seminar (DS)

- **Elementary / Fundamental Science courses (FSC):**

These courses include fundamental science courses crafted for engineering students. These courses are of 4 credits each.

M.Tech. Mechanical Engineering: Two-Year (4-Semester) CBCS Programme			
Basic Structure: Distribution of Courses			
S.No.	**Type of Course**	**Credit**	**Total Credits**
1	**Elementary / Fundamental Science courses (FSC)**	02 Courses of 4 Credits each (Total Credit 2X4)	08
2	**Engineering Core courses (ECC)**	06 Courses of 4 Credits each (Total Credit 6X4)	24
3	**Engineering Departmental Elective (EDE)**	03 Courses of 4 Credits each (Total Credit 3X4)	12
4	**Dissertation/Seminar (DS)**	02 Courses of 2 Credits each (Total Credit 2X2) 01 Course of 10 Credits (Total credit 1x10)	14
Total Credits			**58**

- **Engineering Core courses (ECC):**

Engineering Core courses of M.Tech program will provide a holistic approach to master education, giving students an overview of the field, a basis to build and specialize upon. These core courses are the strong foundation to establish engineering knowledge and provide broad multi-disciplined knowledge can be studied further in depth during the elective phase.

The core courses will provide more practical-based knowledge, case-based lessons and collaborative learning models. It will train the students to analyze, decide, and lead-rather than merely know-while creating a common student experience that can foster deep understanding, develop decision-making ability and contribute to the business and community at large.

A wide range of core courses provides groundwork in the basic engineering disciplines: The integrated foundation is important for students because it will not only allow them to build upon existing skills, but they can also explore career options in a range of industries, and expand their understanding of various research fields.

- **Engineering Departmental Elective (EDE):**

Engineering departmental Elective is an interdisciplinary additional subject that is compulsory in the first,

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second and third semester of a program. The score of Electives is counted in your overall aggregate marks under Choice Based Credit System (CBCS). Each Elective paper will be of 4 Credits and students will have the choice of taking electives. Each student has to take Electives from department other than the parent department. These courses are of 4 credits each.

- **Dissertation/Seminar (DS):**

1. Dissertation with a department faculty.
2. The students, who take up experiential dissertation in companies, where senior executives with a stake in teaching guide them, drive the learning. All students are encouraged to do some live project other than their regular classes.
3. Industrial visit are essential to give students hand-on exposure and experience of how things and processes work in industries. Our institute organizes such visits to enhance students' exposure to practical learning and work out for a report of such a visit relating to their specific topic, course or even domain.

Evaluation of Performance

1. Programmes: Evaluation of performance of the students in a programme shall be a continuous process based on their performance in the class test, assignments and the end semester examinations.

Theory papers in semester system (Maximum Marks: 100)
The evaluation will be done through two class test and one end semester examination. This will be in addition to assignments, attendance, etc. Each class test will carry a weightage of 10 marks, and the end semester examination will carry a weightage of 70 marks. The remaining 10 marks will be awarded on the basis of attendance and performance in quizzes and assignments.

2. Dissertation, Seminar: Seminar, Dissertation, and other learning-oriented activities shall have associated maximum marks and credits, as stated in the syllabus.

3. Examination:
a. The minimum Grade required to pass in each Theory & Practical paper is 'GRADE D'.
b. A candidate, in order to pass, minimum CGPA of 4.50 is required in a particular academic year inclusive of both semesters of that academic.
c. There shall be no minimum Grade required to pass in General Proficiency (GP). However, Grade obtained in General Proficiency (GP) shall be included in SGPA.
d. For further information, examination ordinance of IFTM University can be followed.

Evaluation Scheme:			
	Internal	**External**	**Total**
Theory	**30**	**70**	**100**
Seminar	**100**	**--**	**100**
Pre-Dissertation	**50**	**50**	**100**
Dissertation	**250**	**250**	**500**

Unique practices adopted:

The method and practice of teaching, especially for teaching an academic subject or theoretical concept". In addition to conventional time-tested lecture method, the institute will emphasize on **experiential learning.**

Audio-Visual Based Learning:
It is clear that audio visual aids are important tools for teaching learning process. It helps the teacher to present the lesson effectively and students learn and retain the concepts better and for longer duration. Use of audio-visual aids improves student's critical and analytical thinking. It helps to remove abstract concepts through visual presentation.

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However, improper and unplanned use of these aids can have negative effect on the learning outcome. Therefore, teachers should be well trained through in-service training to maximize the benefits of using these aids. The curriculum should be designed such that there are options to activity-based learning through audio-visual aids. In addition, government should fund resources to purchase audio-visual aids in colleges

Field / Live Projects:
The objective of their training program is to enhance knowledge of the students on any one of the Trending technologies according to the industry standards without which the student degree is a mere degree. This is done by making students work on live projects which equip them with the required skill needed for the corporate world.

Personality Development Program (PDP):
It is conducted by professional trainers/experts from corporates as also by dedicated in-house faculty to actually bring a change in the traits of students in terms of values, behavior and personal growth. It enhances their body language, self-discipline, includes boosting one's confidence, improving language speaking abilities and widening one's scope of knowledge. Following PDP programs are undertaken in the Institute.

- **Aptitude:** Prepare students for placements by enhancing students' understanding in reasoning, numeric aptitudes, language proficiencies and general awareness.
- **Resume Writing:** Trains students about the current trend to present their Personal, Educational & Professional achievements and Strengths in an impressive manner. They learn how to write covering letter through which they can efficiently present their extra information. They also get an exposure to the Social Professional Sites like LinkedIn.
- **Group Discussion:** Help students to improve their ability to understand a topic/idea from different perspectives. They are able to realize its importance as a standard recruitment and selection tool. Students are trained to demonstrate their leadership, team work, oral and body language skills.
- **Personal Interview:** A platform to train students in improving their listening abilities and handling interviewer's questions and answer accordingly so that they are able to remove hesitation and anxiety during placement process.

Student Development Programs (SDP):
SDP has various modules dealing with professional development, Awareness and opinion building, communication and self-presentation etc. The purpose of these modules is to help students grow as individuals, develop the power of critical thinking and, at a material level, secure better placements

Special Guest Lectures (SGL):
Guest lectures are a highly useful medium to provide exceptional knowledge to students, it also adds an extra variety to the classroom routine and universities put a lot of emphasis on the importance of Guest lectures. The Guest lecturers are the "real-world" arriving in the classroom in order to make classes more interesting.

Industrial Visits:
Industrial visits are an integral part of Engineering and acknowledgment of technological up gradation. Industrial visit is considered as one of the tactical methods of teaching. The main reason behind this, it lets student to know things practically through interaction, working methods and employment practices. Moreover, it gives exposure from academic point of view. Main aim of industrial visit is to provide an exposure to students about practical working environment. They also provide students a good opportunity to gain full awareness about industrial practices. Through industrial visit students get awareness about new technologies. Technology development is a main factor, about which a students should have a good knowledge. Visiting different companies actually help students to build a good relationship with those companies.

Industry Focused programs:
Industry oriented education is an approach to learning from an industry perspective where core subjects are taught in the context of application of that knowledge to product design, development and operation. Establishing collaborations with various industry partners to deliver the programme on sharing basis. The specific courses/contents are to be delivered by industry experts to provide practice based insight to the students.

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Mentoring scheme:
The new process has been established as Mentoring System". Each faculty will be the mentor of a group of 20 to 25 students. Every Student shall be provided with a faculty Mentor to help him /her in their personal & Academic Issues. The mentor maintains a register of all his/her mentees with complete personal & parents 'details. It is essential to have at least to meet once in a month. The mentor enters the discussions held, advice given and efforts & improvements made by the mentee.

Extracurricular Activities:
In IFTM University, various Co-Curricular and Extra-Curricular activities are regularly conducted along with regular Academic activities and students are continuously inspired and motivated to participate in these various activities to ensure the overall development of the students.

- **Cultural Activities:** The various activities undertaken are – Singing, Dancing, Playing Musical Instruments, Compering, Skit, Band, Stand-up Comedy, Poetry, Fashion Show etc. These activities help to develop self-confidence, cultural interest, creativity and sense of cooperation among students.

- **Games & Sports:** IFTM strongly believes that a healthy physique leads to a healthy mind. The Institute encourages sports culture and students also reciprocate by actively participating and distinguishing themselves at Sports Meets. IFTM possesses proper playgrounds and hard courts for outdoor sports. In Boys hostels students enjoy the facilities of Gym, badminton, and Table Tennis. The various sports activities undertaken are – cricket, football, basketball, volley ball, carom, chess, badminton, athletics etc. They increase self-esteem & mental alertness among students and promote team spirit. They also lead to balanced mental and physical growth of the students and teach them life skills like discipline, teamwork, leadership, patience, perseverance etc.

- **Induction program:** Every year induction program is organized for 1st year students to make them familiarize with the entire academic environment of university including Curriculum, Classrooms, Labs, Faculty/ Staff members, Academic calendar and various activities.

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SCHOOL OF ENGINEERING & TECHNOLGY
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(Established under UPGovt.ActNo.24 of 2010 and approved under section 22 of UGC Act 1956)
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DEPARTMENT OF MECHANICAL ENGINEERING
CBCS Programme
Effective from Session 2021-22

Course Code		CBCS BASKET		Credits			
Elementary/Fundamental Science courses(FSC)				**L**	**T**	**P**	**C**
TMME101		Advanced Operations Research		3	1	0	4
TMME201		Numerical Methods & Analysis		3	1	0	4
Engineering Core Courses(ECC)				**L**	**T**	**P**	**C**
TMME102		Advanced Thermal Engineering		3	1	0	4
TMME103		Modeling and Simulation		3	1	0	4
TMME202		Advanced Mechanics of Solids		3	1	0	4
TMME203		Combustion Engineering		3	1	0	4
TMME301		Production Technology		3	1	0	4
TMME302		Non Destructive Testing		3	1	0	4
Engineering Departmental Elective (EDE)				**L**	**T**	**P**	**C**
Elective - I	TMME 111	Advanced Mechanics of Solids	**GROUP - A**	3	1	0	4
	TMME 112	Advanced Material Technology		3	1	0	4
	TMME 113	Production, Planning and Control		3	1	0	4
	TMME 114	Interfacial Tribology		3	1	0	4
	TMME 115	Metal Casting		3	1	0	4
	TMME 116	Machining Science		3	1	0	4
	TMME 117	Advanced Welding Technology	**GROUP - B**	3	1	0	4
	TMME 118	CNC, FMS & CIM		3	1	0	4
	TMME 119	Unconventional Machining		3	1	0	4
	TMME 120	Enterprise Resource Planning		3	1	0	4
	TMME 121	Advanced Computer Aided Design		3	1	0	4
	TMME 122	Advanced Machine Design		3	1	0	4
	TMME 123	Fracture Mechanics		3	1	0	4
Elective - II	TMME 211	Industrial Automation and Robotics	**GROUP - A**	3	1	0	4
	TMME 212	Advanced Mechanical Vibrations		3	1	0	4
	TMME 213	Supply Chain Management		3	1	0	4
	TMME 214	Heat Treatment Processes		3	1	0	4

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	TMME 215	Design of Production Tooling		3	1	0	4
	TMME 216	Machine Tool Design		3	1	0	4
	TMME 217	Product Design and Development	GROUP - B	3	1	0	4
	TMME 218	Industrial Design and Ergonomics		3	1	0	4
	TMME 219	Micro Manufacturing		3	1	0	4
	TMME 220	Concurrent Engineering		3	1	0	4
	TMME 221	Reliability, Maintenance, Management, and Safety		3	1	0	4
	TMME 222	Theory of Plasticity		3	1	0	4
	TMME 223	Rapid Prototyping and Tooling		3	1	0	4
Elective - III	TMME 311	Neural Network and Fuzzy Systems		3	1	0	4
	TMME 312	Micro-Electro-Mechanical Systems		3	1	0	4
	TMME 313	Advance Instrumentation		3	1	0	4
	TMME 314	Industrial Tribology		3	1	0	4
	TMME 315	Advance Fluid Mechanics		3	1	0	4
	TMME 316	Total Quality Management		3	1	0	4
	TMME 317	Engineering Design Optimization		3	1	0	4
	TMME 318	Research Methodology		3	1	0	4
	TMME 319	Nanotechnology and its Applications		3	1	0	4
	TMME 320	Gas Turbines and Jet Propulsion		3	1	0	4
	TMME 321	Design of Experiments		3	1	0	4
	TMME 322	Technology of Competitive Manufacturing		3	1	0	4
	TMME 323	Energy Conservation and Management		3	1	0	4
Dissertation/Seminar (DS)				**L**	**T**	**P**	**C**
	TMME351	Seminar		0	0	4	2
	TMME352	Pre-Dissertation		0	0	4	2
	TMME451	Dissertation Work		0	0	20	10

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SCHOOL OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
IFTM UNIVERSITY, MORADABAD

Master of Technology (M. Tech) Mechanical Engineering
(Effective from Session 2022-23)

STUDY AND EVALUATION SCHEME
YEAR I, SEMESTER- I

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	FSC	TMME101	ADVANCED OPERATIONS RESEARCH	3	1	0	20	10	30	70	100	4
2.	ECC	TMME102	ADVANCED THERMAL ENGINEERING	3	1	0	20	10	30	70	100	4
3.	ECC	TMME103	MODELING AND SIMULATION	3	1	0	20	10	30	70	100	4
4.	EDE	TMME1	ELECTIVE – I	3	1	0	20	10	30	70	100	4
TOTAL				**12**	**04**	**00**	-	-	-	-	**400**	**16**

Elective – I

Group A		Group B	
TMME111	ADVANCED MECHANICS OF SOLIDS	TMME117	ADVANCED WELDING TECHNOLOGY
TMME112	ADVANCED MATERIALS TECHNOLOGY	TMME118	CNC, FMS & CIM
TMME113	PRODUCTION, PLANNING AND CONTROL	TMME119	UNCONVENTIONAL MACHINING
TMME114	INTERFACIAL TRIBOLOGY	TMME120	ENTERPRISE RESOURCE PLANNING
TMME115	**METAL CASTING**	TMME121	ADVANCED COMPUTER AIDED DESIGN
TMME116	MACHINING SCIENCE	TMME122	ADVANCED MACHINE DESIGN
		TMME123	FRACTURE MECHANICS

Note: The student has to select Elective from same group in each semester.

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Master of Technology (M. Tech) Mechanical Engineering
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STUDY AND EVALUATION SCHEME
YEAR I, SEMESTER- II

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	FSC	TMME201	NUMERICAL METHODS & ANALYSIS	3	1	0	20	10	30	70	100	4
2.	ECC	TMME202	ADVANCED MECHANICS OF SOLIDS	3	1	0	20	10	30	70	100	4
3.	ECC	TMME203	COMBUSTION ENGINEERING	3	1	0	20	10	30	70	100	4
4.	EDE	TMME2	ELECTIVE –II	3	1	0	20	10	30	70	100	4
TOTAL				**12**	**04**	**00**	-	-	-	-	**400**	**16**

Elective – II

Group A		Group B	
TMME211	INDUSTRIAL AUTOMATION & ROBOTICS	TMME217	PRODUCT DESIGN AND DEVELOPMENT
TMME212	ADVANCED MECHANICAL VIBRATIONS	TMME218	INDUSTRIAL DESIGN AND ERGONOMICS
TMME213	SUPPLY CHAIN MANAGEMENT	TMME219	MICRO MANUFACTURING
TMME214	**HEAT TREATMENT PROCESSES**	TMME220	CONCURRENT ENGINEERING
TMME215	DESIGN OF PRODUCTION TOOLING	TMME221	RELIABILITY, MAINTENANCE, MANAGEMENT, AND SAFETY
TMME216	MACHINE TOOL DESIGN	TMME222	THEORY OF PLASTICITY
		TMME223	RAPID PROTOTYPING AND TOOLING

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Note: The student has to select Elective from same group in each semester.

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STUDY AND EVALUATION SCHEME
YEAR II, SEMESTER-III

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
THEORY												
1.	ECC	TMME301	PRODUCTION TECHNOLOGY	3	1	0	20	10	30	70	100	4
2.	ECC	TMME302	NON DESTRUCTIVE TESTING	3	1	0	20	10	30	70	100	4
3.	EDE	TMME3	ELECTIVE-III	3	1	0	20	10	30	70	100	4
PRACTICALS / PROJECT												
4.	DS	TMME351	SEMINAR	0	0	4	-	-	100	-	100	2
5.	DS	TMME352	PRE-DISSERTATION	0	0	4	-	-	50	50	100	2
TOTAL				**09**	**03**	**08**	-	-	-	-	**500**	**16**

Elective – III

TMME311	NEURAL NETWORK AND FUZZY SYSTEMS
TMME312	MICRO-ELECTRO-MECHANICAL SYSTEMS
TMME313	ADVANCE INSTRUMENTATION
TMME314	INDUSTRIAL TRIBOLOGY.
TMME315	ADVANCE FLUID MECHANICS
TMME316	**TOTAL QUALITY MANAGEMENT**
TMME317	INDUSTRIAL AUTOMATION AND ROBOTICS
TMME318	RESEARCH METHODOLOGY
TMME319	NANOTECHNOLOGY AND ITS APPLICATIONS
TMME320	GAS TURBINES AND JET PROPULSION
TMME321	DESIGN OF EXPERIMENTS
TMME322	TECHNOLOGY OF COMPETITIVE MANUFACTURING
TMME323	ENERGY CONSERVATION AND MANAGEMENT

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IFTM University, Moradabad
Department of Mechanical Engineering

Master of Technology (M. Tech) Programme
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STUDY AND EVALUATION SCHEME
YEAR II, SEMESTER-IV

S.N.	Category	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
							Mid Term Exam			External Exam		
				L	T	P	CT	AS +AT	Total			
PRACTICALS / PROJECT												
1.	DS	TMME451	DISSERTATION WORK	0	0	20	-	-	250	250	500	10
TOTAL				-	-	**20**	-	-	-	-	**500**	**10**

Note: Dissertation to be started in III Semester and continued in IV Semester.

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TMME101: ADVANCED OPERATIONS RESEARCH

Objective: - The main aims of this course are to provide suitable and effective knowledge in concepts and tools of Operations Research. To understand mathematical models used in Operations Research.To apply these techniques constructively to make effective decisions in the field of engineering. Learn and understand different methods and applications to optimize the results and solutions to provide employability, skill and entrepreneurship development.

UNIT I **(08 Sessions)**

Introduction: Definition and scope of OR, Techniques and tools, model formulation, general methods for solution, Classification of Optimization problems, Optimization techniques; **Linear Optimization Models:** Complex and revised Simplex algorithms, Degeneracy and duality, Post optimum and Sensitivity analysis, Assignment, transportation and transshipment models, Traveling salesman problem, Integer and parametric programming for skill development.

UNIT II **(08 Sessions)**

Game Problems: Minimax criterion and optimal strategy, two persons zero sum game, Games by Simplex dominance rules.

Waiting Line Problems: Classification of queuing problems, M/M/1 & M/M/1/N queuing systems, Steady state analysis of M/M/m queues, Discrete and continuous time Markov models, Chapman-Kolmogorov equation, Birth & death processes in manufacturing, Open and Closed queuing networks for skill development and employability.

UNIT III **(08 Sessions)**

Inventory Management: ABC analysis, deterministic and Probabilistic models for skill development and employability.

UNIT IV **(08 Sessions)**

Dynamic Programming: Characteristics of dynamic programming problems, Bellman's principle of optimality, Problems with finite number of stages for skill development and employability.

UNIT V **(08 Sessions)**

Stochastic Programming: Basic concepts of Probability theory, Stochastic linear programming for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Demonstrate the operation research theory, application, and algorithms relevant to solving linear programming problems for skill development.

CO2: Understand the various data structures available in game theory and apply them in solving computational problems for skill development and employability gaining national and international interest.

CO3: Identify the goals and objectives of inventory management and describe the importance of stocks in an organization and the reasons for holding stock for skill development and employability.

CO4: To develop dynamic programming associated with network flows and related real life applications for skill development and employability and develops local and global interest.

CO5: Know various discrete and continuous probability distributions along with their characteristics and identify the situations where they provide realistic models for skill development and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	2	3	1	1	3	1	2
CO2	3	2	3	1	1	1	3	2	2	1
CO3	3	2	3	2	3	2	3	1	1	2
CO4	2	1	1	1	3	2	1	3.	3	1
CO5	3	2	3	3	1	3	1	1	2	1

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	2	2
CO2	3	3	1
CO3	3	3	2
CO4	3	3	2
CO5	3	3	2

Suggested Readings:

1. Elements of Queuing Theory SaatyPitam: Tata Mc Graw-Hills Company (Pvt.) Ltd.
2. Nonlinear and Dynamic Programming Hadley Addison Wesley
3. Fundamentals of Operations Research Ackoff&Sasieni Wiley eastern
4. Principles of OR with Applications to Managerial Decisions Wagner Prentice Hall
5. Operations Research: Taha, McMillan
6. Operations Research R Panneerselvam Prentice Hall of India
7. Operations Research A P Verma S.K. Kataria& Sons
8. Introduction to Operations Research Hillier and Lieberman Prentice Hall

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- www.dmi.gov.in
- www.yourarticlelibrary.com
- onlinecourses.nptel.ac.in
- en.wikipedia.org

Note: Latest editions of all the suggested readings must be used.

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TMME102: ADVANCED THERMAL ENGINEERING

Objective: To impart knowledge on the principles of energy quality and the significance of the same for industrial and domestic applications of thermal systems. To impart knowledge on the real gas behaviour and the application of statistical thermodynamic towards understanding the same.To impart knowledge on different thermodynamic property relations and their applications to provide employability, skill and entrepreneurship development.

UNIT I **(06 Sessions)**
Basic Definitions & Concepts, Equation of state, Calculation of thermodynamic properties, generalized compressibility charts for skill development and employability.

UNIT II **(06 Sessions)**
Second law analysis, Availability, irreversibility, Maxwell equations, Joule-Thomson coefficient, Thermodynamics of reactive mixtures, Stoichiometryfor skill development and employability.

UNIT III **10 Sessions)**
Generalized conduction equation, steady and unsteady heat conduction in a slab of finite thickness; Effect of heat generation; Non-zero initial conditionfor skill development and employability.

UNIT IV **(08 Sessions)**
Constant flux and convective boundary conditions, Heat conduction in an inhomogeneous medium; Examples of composite media for skill development and employability.

UNIT V **(10 Sessions)**
Radiation heat transfer, Surface properties, Configuration factor, Radiative heat exchange between gray surfaces. Navier-Stokes equation, Stream function, Velocity potential, Vorticity and circulation potential flow theory, Boundary layer theory for skill development and employability.

Course Outcome: Students completing this course will be able to:

CO1: To understand the basic definitions & concepts, Equation of State, calculation of thermodynamic properties and Generalized Compressibility Chat for skill development and employability gaining national and international interest.

CO2: To understand the Second law analysis, Availability, Irreversibility, Maxwell equations, Joule-Thompson co-efficient, Thermodynamic of reactive mixtures and Stoichiometry for skill development and employability.

CO3: To understand the generalized conduction equation, steady and unsteady heat conduction in a slab of finite thickness; Effect of heat generation; Non-zero initial condition for skill development and employability.

CO4: Develops local and global interest by understanding the Constant flux and convective boundary conditions, Heat conduction in an inhomogeneous medium; Examples of composite media for for skill development and employability.

CO5: To understand the Radiation heat transfer, Surface properties, Configuration factor, Radiative heat exchange between gray surfaces. Navier-Stokes equation, Stream function, Velocity potential, Vorticity and circulation potential flow theory, Boundary layer theory for skill development and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	3	1	2	1	3	1	1	2
CO2	1	3	1	3		2	2	2	3	2
CO3	3	2	1	3	3	1	2	1	1	3
CO4	2	1	3	1	3	1	3	2	1	1
CO5	3	2	3	2	1	3	1	1	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	2

Suggested Readings:

1. Engineering thermodynamics by Jones & Dugan
2. Engineering thermodynamics by Achuthan
3. Thermal Engineering by Sarkar
4. Thermal Spraying for Power Generation Components by Klaus Erich Schneider

Website Sources:

- https://nptel.ac.in
- https://www.wikipedia.org
- https://www.youtube.com
- http://www.thapar.edu/

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TMME103: MODELING AND SIMULATION

Objective: The objective of this course is to familiarize the students to collect the knowledge about the system and its behavior and to solve a real world system by using different simulation software toprovide employability and skill development.

UNIT I **(09 Sessions)**

Introduction: A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation. Physical Modeling: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation for skill development and employability.

UNIT II **(09 Sessions)**

System Simulation: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages. System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams for skill development and employability.

UNIT III **(08 Sessions)**

Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs for skill development and employability.

UNIT IV **(07 Sessions)**

Simulation of Mechanical Systems: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic system for skill development and employability.

UNIT V **(07 Sessions)**

Simulation of Manufacturing Systems: Simulation of waiting line systems, Job shop with material handling and Flexible manufacturing systems, Simulation software for manufacturing, Case studies for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Study the internal behavior (perhaps unobservable) of the system e.g. biological system for skill development and employability.
CO2: Understand and study various types of models used in system study for skill development and employability gaining national and international interest.
CO3: Understand different types of simulation techniques for skill development and employability.
CO4: Understand and apply simulation techniques in mechanical system e.g. translational system for skill development and employability.
CO5: Understand and apply simulation in manufacturing system e.g. flexible manufacturing system, waiting line etc. for skill development and employability and develops local and global interest.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	2	3	2	1	2	3
CO2	2	1	3	1	2	1	3	2	1	1
CO3	1	2	3	2	1	3	1	1	2	2
CO4	3	2	3	1	2	1	1	1	1	2
CO5	1	3	1	3	1	2	3	2	3	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	3	2
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1

Suggested Readings:

1. System Simulation, Geoffrey Gordon, Prentice Hall
2. System Simulation: The Art and Science, Robert E. Shannon, Prentice Hall
3. System Modeling and Control, J. Schwarzenbach and K.F. Gill, Edward Arnold
4. Modeling and Analysis of Dynamic Systems, Charles M Close and Dean K. Frederick Houghton Mifflin
5. Simulation of manufacturing, Allan Carrie John, Wiley & Sons

Website Sources:

- www.wikipedia.org
- http://acqnotes.com
- www.youtube.com
- www.researchgate.netwww.slideshare.net
- https://onlinecourses.nptel.ac.in

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TMME111: ADVANCED MECHANICS OF SOLIDS

Objective: The objective of the course is to learn the fundamental concepts of stress, strain, and deformation of solids with applications to bars, beams, and columns. Detailed study of engineering properties of materials is also of interest. Fundamentals of applying equilibrium, compatibility, and force-deformation relationships to structural elements are emphasized. The students are introduced to advanced concepts of flexibility and stiffness method of structural analysis for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Fundamental concepts of stress, strain, and deformation of solids with applications to bars, beams, columns material properties for employability and skill development.

Unit II **(08 Sessions)**
Analysis of 3-dimesional stress and strain, Constitutive relationships, failure theories, Torsional non-circular sections, Plane stress and plain strain problems, Fatigue analysis, Introduction to fracture mechanics for employability and skill development.

Unit III **(08 Sessions)**
In elastic behavior, Visco-elasticity, Structure and behavior of polymers, Composites and their applications, Behaviour of unidirectional composites and orthotropic lamina, Failure theories for fibre composites, development of various structures in composites to develop entrepreneurship skills.

Unit IV **(08 Sessions)**
Fundamentals of applying equilibrium, compatibility, and force-deformation relationships to structural elements are emphasized for employability and entrepreneurship skills.

Unit V **(08 Sessions)**
Theory of laminates, Photo-elasticity in experimental stress analysis, Computer based analysis and solutions to problems in mechanics of solidsfor skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Elementary understanding of the concepts of stress and strain in mechanics of solids and structures and material properties for employability and skill development.

CO2: Applythefundamentalconceptsof3-dimesionalstressandstrain,Constitutiverelationships,failuretheories,Torsionofnon-circularsections,andstress-strainrelationshipstothe solidandstructural mechanicsproblems for employability and skill development gaining national and international interest.

CO3: Analyze Structure and behavior of polymers, Composites and their applications, development of various structures in composites to develop entrepreneurship skills.

CO4: Applying equilibrium, compatibility, and force-deformation relationships to structuralelements are emphasized for employability and entrepreneurship skills and develops local and global interest.

CO5: Understand the theory of laminates, computer based analysis and solutions to problems in mechanics of solids for skill development and employability.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	3	3	3	3	2	2	2	3
CO 2	2	1	3	3	2	1	3	2	1	1
CO 3	1	2	3	2	2	3	1	1	2	2
CO 4	2	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	3	2
CO 3	2	2	3
CO 4	2	3	3
CO 5	3	3	1

Suggested Readings:

1. A K Singh, Mechanics of Solids, Prentice Hall of India
2. Kanninen,MelvinF,Popelar,CarlHandC.H.Popelar,AdvancedFractureMechanics,OxfordUniversity
3. IsaacM.DanielOriIshai,EngineeringMechanicsofCompositeMaterials,OxfordUniversity
4. JonesR.M.,MechanicsofCompositeMaterials,TechnomicPublishingCompany
5. Ronald F. Gibson, Mechanics of Composite Materials, Mc-Graw Hill
6. MadhujitMukhopadhyay, Mechanics of Composite Materials, Universities Press

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.co

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TMME112: ADVANCED MATERIALS TECHNOLOGY

Objective: The objective of this course is to understand the basics of materials and their classification and familiarize the students to gain insight about strengthening mechanism of materials through various testing tools/models and understanding the advanced concept of composites, polymers, super alloys etc. and their industrial application for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

Solid materials- Classification, Ceramics, composites and metal glasses, selection and application of tool steel, Magnetic alloys, Copper, aluminum and magnesium alloys, Bearing alloys, Super hard materials, Plastics, Alloying techniques-Thermal, mechanical and chemical methods, Power metallurgy techniques, Macro and micro analysis of materials, Macro analysis of ferrous and nonferrous materials, Dendritic structures, Segregation and bonding, Heterogeneity formed through treatment and mechanical working for employability and skill development.

Unit II **(08 Sessions)**

Strengthening mechanism of materials, elements of dislocation theories, Strain hardening, Grain size control, Single crystal growth, Reinforcing fibres for polymers, Composite structure, determination of mechanical properties of materials, Dynamic tests, Fracture and toughness tests, Low temperature and high temperature tests, Creep characteristics, Hot hardness tests, Total intragranular cracking and aggressive media, Ceramics and composites, Insulation, Strength and aging of plastics to have skill development.

Unit III **(08 Sessions)**

Plastic working of materials, Strain hardening, Recovery and recrystallization, Failure-Quality loss and robust design, Service failure modes, Characterization and interpretation, Deformation modes-Yielding and creep, Ductile and brittle fracture-Fatigue and fracture mechanics approach to design, Cumulative damage-Life prediction, Wear modes and control, Systematic approach to failure analysis to develop employability and entrepreneurship skills.

Unit IV **(08 Sessions)**

Super alloys-refractory materials, Ceramic and their applications, Low melting alloys, Shape memory alloys, Advanced Composites-Particulate and dispersion composites, Metal matrix and ceramic matrix composites, Carbon-Carbon composites, Ti and Ni based alloys for gas turbine applications for skill development and employability.

UNIT V **(08 Sessions)**

Managing and cryogenic steels- Newer materials and their treatment for automobile applications, materials for Naval and nuclear systems.Smart and Nano materials. Polymers and polymerization, Structure and properties of thermoplastics and thermosets, Engineering applications, Property modifications, Mechanical, thermal behaviour of composites with polymer matrix, ceramics glasses for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of materials for employability and skill development.
CO2: To apply various testing methods in alloys, composites, ceramics configurations to developskills.
CO3: Facilitate employability and entrepreneurship skills by understanding the importance of plastic working of materials.
CO4: Understand the concept of super alloys-refractory materials, ceramics, alloys, composites and Ti and Ni based alloys for gas turbine applications for skill development and employability and develops local and global interest.
CO5: To develop techniques/models for creating newer materials and their treatment for automobile, military, naval and nuclear applications for employability and entrepreneurship skills development.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	1
CO 3	1	3	3
CO 4	3	3	1
CO 5	2	3	3

Suggested Readings:

1. Engineering Materials and Applications P. Flinn and P.K. Trojan MIR Publications
2. Engineering Materials: Polymers, Ceramics and Composites A. K Bhargava Prentice Hall of India
3. Manufacturing processes for Engineering Materials SeropeKalpakjian Wesley Publishing Co.
4. An introduction to Physical Metallurgy S.H. Avner McGraw Hill
5. Advances in Materials and Their Applications P. Rama Rao Wiley Eastern
6. Mechanical Metallurgy Dieter McGraw Hill

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME113: PRODUCTION, PLANNING AND CONTROL

Objective: Production planning is an activity that is performed before the actual production process takes place. It involves determining the schedule of production, sequence of operations, economic batch quantities, and also the dispatching priorities for sequencing of jobs. Production control is mainly involved in implementing production schedules and is the corollarytoshort-termproductionplanningorscheduling.Productioncontrolincludesinitiating production, dispatching items, progressing and then finally reporting back to production planning. In general terms, production planning means planning of the work to be done later and production control refers to working out or the implementation of the plan for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Function of production, planning and control, Its importance in an organization, Manufacturing systems, Product development and design, Product analysis, Product characteristics, Break even analysis, Step-wise cost function, Cost-profit-volume charts, Economics of new design, Sales forecasting and estimating, Sales trend analysis and activity charts for employability and entrepreneurship skills.

Unit II **(08 Sessions)**
Production order, Quantity in batch production, Stock control, Minimum profit batch size, Maximum profit batch size, Maximum rate of return batch size, Production range for skill development and employability.

Unit III Machine capacity, Machine operation, Multi machine supervision by one operator, Machine interface, Balancing, Profit maximization for employability and skill development.

Unit IV **(10 Sessions)**
Different forms of scheduling, Sequencing, Scheduling-maximum profit for whole schedule, Maximum return to whole schedule for employability and skill development.

Unit V **(06 Sessions)**
Elements of control procedure, Dispatching, Expediting, Computer aided production control, Quality control, JIT system of production control to develop entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the Function of production, planning and control, Its importance in an organization, Economics of new design, Sales forecasting and estimating, Sales trend analysis and activity charts for employability and entrepreneurship skills gaining national and international interest.
CO2: To apply production facilities in the best possible manner along with the proper systematic planning of production activities forskill development and employability.
CO3: Facilitate employability and entrepreneurshipskills by providing men, machines, materials etc. of right quality, quantity and also providing them at the right time forms a very important factor.
CO4: Analyze the Different forms of scheduling, Sequencing, Scheduling-maximum profit for whole schedule, Maximum return to whole schedule for employability and skill development
CO5: To control and develop various elements of control procedure, Dispatching, Expediting, Computer aided production control. Quality control, JIT system of production control develops entrepreneurship skills and develops local and global interest.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	3	3	3	3	2	2	2	3
CO 2	3	1	1	1	2	1	3	2	1	1
CO 3	1	3	3	2	2	3	1	1	2	2
CO 4	3	2	3	1	2	1	2	1	1	2
CO 5	1	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	1	3	3
CO 2	3	3	2
CO 3	1	3	3
CO 4	3	3	2
CO 5	1	2	3

Suggested Readings:

1. Samual Eilon, Elements of Production, Planning and Control,
2. S. K. Mukhopadhaya, Production, Planning and Control, Prentice Hall of India
3. Buffa, Modern Production Management,
4. K. K. Ahuja, Production Management, CBS Publishers
5. tephenN.chapman,Fundamentalsofproductionplanningandcontrol,DorlingKindersley,India,2009

Website sources:

- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.nsf.gov
- en.wikipedia.org

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TMME114: INTERFACIAL TRIBOLOGY

Objective: Tribology has a significant impact on life-cycle and production-cycle issues in all industrial sectors, through the implementation of novel materials and new technologies resulting in performances which up till now remained unachievable. Tribology is most concerned with improving the efficiency and reliability of machinery, production equipment and systems for manufacturing. Through the establishment of prolonged life-times and improved production efficiency it has a major impact on the reduction of raw materials consumption and generation of waste. Raising public and industrial awareness as to the importance of tribology towards a sustainable growth of the industrial European society, The promotion of new materials and technologies to reduce friction and wear, raw material consumption and environmental loading in industrial processing, Promote standardization of characterization and test methods in the field of Tribologyfor entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

Basic concepts, Definition and scope of tribology in engineering applications. Work die interface ,interaction between lubricant, work piece and die Hydrodynamic action at work-die interface for skill development and employability.

Unit II **(08 Sessions)**

Interfacial friction: Mechanisms of friction applicable to forming processes, effect on pressure and die loads. wear; definition, classification, adhesive, abrasive, surface fatigue and corrosive &erosive wear, cavitation and fretting wear for employability and skill development.

Unit III **(08 Sessions)**

Lubrication in metal working: Different regimes of lubrication, attributes of a good lubricant, properties composition and characteristics. Lubricants for industrial processes, e.g. rolling, forging, extrusion, sheet metal etc. to develop entrepreneurship skills.

Unit IV **(08 Sessions)**

Analysis of basic processes under different Tribological conditions, governing equations, yield criteria & flow rules, Reynold's equationfor skill development and employability.

Unit V **(08 Sessions)**

Analysis of pressure distribution & die loads for rolling, forging, wire drawings, extrusion. Hydrostatic extrusion, hydro dynamic wire drawing, water hammer forming, melts spin processforemployability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the basic concepts, Definition and scope of Tribology in engineering applications for employability and skill development.
CO2: Analyze the mechanisms of friction applicable to forming processes and effect on pressure, wear, adhesive, abrasive, surface fatigue and corrosive & erosive wear, cavitation and fretting wear for employability and skill development
CO3: To apply various type of Lubrications use in metal working, different regimes of lubrication, attributes of a good lubricant, Lubricants for industrial processes, e.g. rolling, forging, extrusion, sheet metal etc. to develop entrepreneurship skills.
CO4: Analyze the basicprocessesunderdifferentTribologicalconditions, governingequations,yieldcriteria&flow rules,for skill development and employability and develops local and global interest.
CO5 To control the pressure distribution & die loads for rolling, forging, wire drawings, extrusion, water hammer forming, melt spin process for employability and entrepreneurship skills

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	3	3	3	3	2	2	2	3
CO 2	2	1	3	3	2	1	3	2	1	1
CO 3	1	2	3	2	2	3	1	1	2	2
CO 4	2	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	3	2
CO 3	1	2	3
CO 4	3	3	1
CO 5	2	3	3

Suggested Readings:

1. J.A.Schey,MarcelDebber,MetalDeformationProcesses,FrictionandLubrication,INC,NewYork
2. Surender Kumar, Technology of Forming Processes, Prentice Hall
3. John A. Schey, Tribology in Metal Working, ASME, OMIO
4. Sushil Kumar Srivastava, Tribology in Industries, S. Chand
5. Theomang, Kirstenbobzin an Thorstenbartels, Industrial Tribology, Wiley-VCH

Website sources:

- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com
- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org

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TMME115: METAL CASTING

Objective: To impart fundamental knowledge of foundry industry, molding with designing aspects like gating and risering systems and solidification of metals. To let them understand for casting the products free from any kind of defects to provide employability, skill and entrepreneurship development.

UNIT I **(08 Sessions)**

Introduction: Features of Casting problems, Survey and Scope of Foundry Industry, Solidification of pure metals, Nucleation and growth in alloys, Solidification of actual casting, Progressive and directional solidification, Centre line feeding resistance, Rate of solidification, Chvorinov's rule, Electrical analog of solidification problems for skill development.

UNIT II **(08 Sessions)**

Gating and Risering Systems: Gating systems and their characteristics, Effects of gates on aspiration, Turbulence and dross trap, recent trends, Riser design, Risering curves, NRL method of riser design, Feeding distance, Risering of complex casting, Risering of alloys other than steel, Riser design by geometrical programming get employability development for foundry industry.

UNIT III **(08 Sessions)**

Moulding and Core Making: Review and critical comparison of various established processes, recent developments e.g. low pressure and ferrous die casting, High pressure moulding, Full mould process, Flasklessmoulding, Hot and cold box moulding, Ceramic shell moulding, V-process, Continuous casting, Squeeze and pressed casting, Nishiyama process, Shaw process, Anitoch process, etc. for employability and skill development.

UNIT IV **(08 Sessions)**

Melting and Fluidity: Selection and control of melting furnaces; molting, refining and pouring; Coupla design, Measurement of fluidity, Effect of various parameters on fluidity, Methods of elimination and control of gases in casting to develop entrepreneurship development.

UNIT V **(08 Sessions)**

Internal Stress, Defects and Surface Finish: Residual stresses, Hot tears and cracks in casting; Stress relief, defects and their causes and remedies; Parameters affecting surface finish and related defects e.g., Rough casting, bum-on sand bum-in metal penetration, Facing and washes; Mold wall movement; transport zones, Expansion scabbing etc.; **Casting of Sand Design Considerations:** Recent developments, e.g., Mulling index; Mouldability index, Compactability; deformability etc. for skill development and employment.

Course Outcome: After completion of this course the students will be able:

CO: 1 Survey and scope of foundry industry and the mechanism of solidifications of solid materials during casting for skill development.
CO: 2 Understand the design of gating and risering system for casting of the products and to get employment in foundry industry gaining national and international interest.
CO: 3 Compare various existing mold and core making methods and design of them by following recent updates for employability and skill development.
CO: 4 Develop entrepreneurship by learning how the melting furnaces for casting of any metal are selected and which parameters affect the fluidity of a material during casting and develops local and global interest.
CO: 5 Understand defects and their causes in casting and to learn recent developments in castings for skill development and employment.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	3	3	3	3	2	2	2	3
CO 2	2	1	3	3	2	1	3	2	1	1
CO 3	1	2	3	2	2	3	1	1	2	2
CO 4	2	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	1	1
CO 2	1	3	1
CO 3	3	3	1
CO 4	2	1	3
CO 5	3	3	1

Suggested Readings:

1. Bronze Sculpture Casting And Patination: Mud Fire Metal Steve Hurst Schiffer Publishing
2. Fine Art Metal Casting Richard Rome -
3. Casting Technology and Cast Alloys Chakraborty Prentice Hall of India
4. Meta Casting: Principles and Practice TV Rammana Rao New Age International
5. Fundamentals of Metal Casting H. Loper and Rosenthal Tata McGraw Hill

Website Sources:

- nptel.ac.in
- http://www.springer.com
- www.indianfoundry.org
- www.sciencedirect.com

Note: Latest editions of the suggested readings must be used.

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TMME116: MACHINING SCIENCE

Objective: The objective of this course inculcates specialized knowledge and skill in machining processes using the principles and methods of engineering analysis and design. This course also cultivates the ability to develop and optimize the conventional machining processes resulting in creation and distribution of value in engineering applications. This course also imparts knowledge about the significance of optimal process parameters used for the optimal performance of various machining processes used in manufacturing industries for entrepreneurship and skill development and employability.

UNIT I **(08 Sessions)**

Mechanics of metal cutting-Tool geometry, Mechanics of orthogonal and oblique cutting, Shear angle relations in orthogonal cutting, Shear angle and chip flow direction in oblique cutting, Chip control methods, Analysis of cutting process, Machining with rotary tools for skill development and employability.

UNIT II **(08 Sessions)**

Thermodynamics of chip formation, Machining at super high speeds, Theories of tool wear, Basic action of cutting fluids, tool life, Factors governing tool life, Machinability-definition and evaluation for employability and entrepreneurship skills.

UNIT III **(08 Sessions)**

Economics of metal cutting-Single and multipass machining operations, Criteria, variables, and restrictions for the economic conditions for employability and skill development.

UNIT IV **(08 Sessions)**

Dynamic metal cutting-Comparison of steady and dynamic process, Shear angle and force relationships, Grinding mechanics, Wheel characteristics and theory of wheel wear, Lapping, Honning, High speed grinding theory, Grinding of drills, form cutters etc., to develop entrepreneurship skills.

UNIT V **(08 Sessions)**

Problems associated with machining of plastics, Tools for plastic cutting, Analysis of nonconventional machining processes ECM, EDM, LBM, WJM, USM etc.for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Analyze the mechanics of metal, cuttingChip control methods, Analysis of cutting process, Machining with rotary tools for skill development and employability.
CO2: Understand the concept of thermodynamics of chip formation, Machining at super high speeds, Machinability and evaluation for employability and entrepreneurship skills gaining national and international interest.
CO3: To control and develop for economics of metal cutting-Single and multipass machining operationsand restrictions for the economic conditions for employability and skill development.
CO4: To apply dynamic metal cutting-Comparison of steady and dynamic process, theory of wheel wear and Grinding of drills, form cutters etc., to develop entrepreneurship skills.
CO5: Facilitateemployability and entrepreneurship skills by understanding the Problems associated with machining of plastics, Tools for plastic cutting, Analysis of nonconventional machining processes ECM, EDM, LBM, WJM, USM etc. anddevelops local and global interest.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	3	1	3	2	2	2	3
CO 2	2	1	3	3	2	1	2	2	1	1
CO 3	1	3	3	2	2	3	1	1	2	2
CO 4	2	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	2	3	3
CO 3	3	3	1
CO 4	2	1	3
CO 5	2	3	3

Suggested Readings:

1. Metalwork and Machining Hints and tips (Workshop Practice), Arnold Throp –
2. Machining Fundamentals, Walker John R Goodheart
3. Introduction to Machining Science, GK Lal New Age International
4. Non-Conventional Machining, P K Mishra Narosa Publishing House

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

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TMME117: ADVANCED WELDING TECHNOLOGY

Objective: The objective of this course is to develop a practical understanding of welding with regard to welding processes, and auxiliary welding equipment for the welder. Also, to develop a technical understanding of the information contained on engineering drawings and the use of the information to communicate setup and welding instructions from the designer to the welder and robotics in welding for entrepreneurship and skill development and employability.

UNIT I **(08 Sessions)**

Welding Metallurgy: Welding as compared with other fabrication processes, Classification of welding processes; Heat affected zone and its characteristics; Effects of alloying elements on weldability, Weldability of steels, stainless steel, cast iron, and aluminum and titanium alloys, Weld testing standards, Hydrogen embrittlement, Lammellar tearing, residual stresses and its measurement, heat transfer and solidification, Analysis of stresses in welded structures, Pre and post welding heat treatments, Metallurgical aspects of joining, Conditions of soldering, Brazing and welding of materialsfor employability and skill development.

UNIT II **(08 Sessions)**

Weld Design & Quality Control: Principles of sound weld design, Welding joint design, Welding defects; Testing of weldment, Material joining characteristics, Welding positions, Allowable strength of welds under steady loads, Weld throat thickness; Weld quality, Discontinuities in welds, their causes and remedies and quality conflicts for employability and entrepreneurship skills.

UNIT III **(08 Sessions)**

Modern Trends in Welding: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Plasma arc welding, Laser welding to develop entrepreneurship skills.

UNIT IV **(08 Sessions)**

Mechanisation in Welding: Mechanisation of flat/circular joints, Thin/thick sheets (resistance/arc weld), Mechanisation of I beams (arc weld), Longitudinal circumferential SA welding (roller blocks, column booms, flux supports), Circular/spherical welding joints (rotating tables positioners), Manufacture of welding longitudinal welded pipes by induction, TIG, Plasma and SA welding of spiral welded pipes for skill development and employability.

UNITV **(08 Sessions)**

Robotics in Welding: Robot design and applications in welding, Programming of welding robots, tolerances for assemblies for robot welding, New generation of welding robots, Self-alignment by current arc variation, Robots for car body welding, Microelectronic welding and soldering, Efficiency of robotics in weldingfor employability and skill development.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept of Welding Metallurgy and Metallurgical aspects of joining, Conditions of soldering, Brazing and welding of materials for employability and skill developmentgaining national and international interest.
CO2: To apply weld design & quality control in welds, their causes and remedies and quality conflicts for employability and entrepreneurship skills.
CO3: Facilitate to develop entrepreneurship skills by understanding the Modern Trends in Welding.
CO4: Analyze the mechanism and Manufacture of welding longitudinal welded pipes by induction, TIG, Plasma and SA welding of spiral welded pipes for skill development and employability and develops local and global interest.
CO5: To control and develop models for Robot design and applications in welding, Programming of welding robots, tolerances for assemblies for robot welding, New generation of welding robots and Efficiency of robotics in welding for employability and skill development.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	3	3	3	3	2	2	2	3
CO 2	2	1	3	3	2	1	3	2	1	1
CO 3	1	2	3	2	2	3	1	1	2	2
CO 4	2	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	1	3	3
CO 3	1	2	3
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Advanced Welding Processes Nikodaco&Shansky MIR Publications
2. Welding Technology and Design V M Radhakrishnan New Age International
3. Source Book of Innovative welding Processes M. M. SchwarizAmerical Society of Metals (Ohio)
4. Advanced Welding Systems, Vol. I, II, III J. CornuJaico Publishers
5. Manufacturing Technology (Foundry, Forming and Welding) P.N. Rao Tata McGraw Hill

Website sources:

- www.sciencedirect.com
- www.slideshare.net
- www.nsf.gov
- en.wikipedia.org
- www.researchgate.net

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TMME118: CNC, FMS & CIM

Objective: The objective of CNC machining is to create a prototype by cutting a block of material into a specific shape, flexible manufacturing system (FMS) is to balance the productivity of the production floor as well as maintaining its flexibility and CIM is to remove all the barriers between all the functions within an operation, to encourage marketing, order entry, accounting, design, manufacturing, quality control, shipping and all the other departments to work closely together throughout the process for entrepreneurship and skill development and employability.

UNIT I **(08 Sessions)**

Introduction to CNC Machine Tools: Development of CNC Technology-Principles and classification of CNC machines, Advantages & economic benefits, Types of control, CNC controllers, Characteristics, Interpolators, Applications, DNC concept for employability and skill development.

UNIT II **(08 Sessions)**

CNC Programming: Co-ordinate System, Fundamentals of APT programming, Manual part programming-structure of part programme, G & M Codes, developing simple part programmes, Parametric programming, CAM packages for CNC machines-IDEAS, Unigraphics, Pro Engineer, CATIA, ESPIRIT, Master CAM etc., and use of standard controllers- FANUC, Heidenhain and Sinumeric control system for employability and entrepreneurship skills.

UNIT III **(08 Sessions)**

Tooling for CNC Machines: Cutting tool materials, Carbide inserts classification; Qualified, semi-qualified and preset tooling, Cooling fed tooling system, Quick change tooling system, Tooling system for machining centre and turning center, tool holders, Tool assemblies, Tool magazines, ATC mechanisms, Tool management **for** skill development and employability.

UNIT IV **(08 Sessions)**

Robotics and Material Handling Systems: Introduction to robotic technology, and applications, Robot anatomy, material handling function, Types of material handling equipment, Conveyer systems, Automated guided vehicle systems, Automated storage/retrieval systems, Work-in-process storage, Interfacing handling and storage with manufacturing todevelop entrepreneurship skills.

UNIT V **(08 Sessions)**

Group Technology and Flexible Manufacturing System: group Technology-part families, Parts classification and coding, Production flow analysis, Machine Cell Design, Benefits of Group Technology, Flexible manufacturing systems- Introduction, FMS workstations, Computer control system, Planning for FMS, Applications and benefit for skill development and employability.

Computer Integrated Manufacturing: Introduction, Evaluation of CIM, CIM hardware and software, Requirements of computer to be used in CIM system, Database requirements, Concurrent engineering-Principles, design and development environment, advance modeling techniques for employability and skill development.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept CNC machine tools, development of CNC machine, Types of control, CNC controllers, Characteristics, Interpolators, Applications, DNC concept for employability and skill development.
CO2: Understand the concept CNC Programming, G & M Codes, developing simple part programmers Pro Engineer, CATIA, ESPIRIT, Master CAM etc., and use of standard controllersfor employability and entrepreneurship skills.
CO3: Facilitate employability and skill development by understanding the robotics and material handling systems.
CO4: Apply and understand the principles of group technology and flexible manufacturing system to develop entrepreneurship skills.
CO5: Analyze and apply the concept of computer integrated manufacturing for employability and skill development and develops local and global interest.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	3	3	3	2	2	2	3
CO 2	2	2	2	2	2	1	3	2	1	1
CO 3	3	1	3	2	2	3	1	1	2	2
CO 4	2	1	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	1	3	3
CO 3	3	3	1
CO 4	2	1	3
CO 5	3	3	1

Suggested Readings:

1. Computer Numerical Control Machines P. Radahkrishnan New Central Book Agency
2. CNC Machines M.S. Sehrawat and J. S. NarangDhanpat Rai and Co.
3. CNC Programming Handbook Smid Peter Industrial Press Inc.
4. Automation, Production systems and Computer Integrated Manufacturing M.P. Groover Prentice Hall of India
5. Computer Integrated Manufacturing Paul Ranky Prentice Hall of India

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

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TMME119: UNCONVENTIONAL MACHINING

Objective: The objective of this course is to familiarize the students to gain insight about an unconventional machining process is a specialized subject for mechanical engineering branch. It provides an insight of machines associated with specialized production. The purpose of this course is also to learn the need for various non–traditional machining methods for entrepreneurship and skill development and employability.

UNIT I **(06 Sessions)**

Introduction: Limitations of Conventional machining processes, Need of advanced machining processes and its classification for employability and skill development.

UNIT II **(08 Sessions)**

Mechanical Type Metal Removal Processes: Ultrasonic machining; Elements of the process; Tool design and economic considerations; Applications and limitations, Abrasive jet and Abrasive water jet machining principles; Mechanics of metal removal; Design of nozzles; applications, Abrasive finishing process, Magnetic abrasive finishing process for skill development and employability.

UNIT III **(10 Sessions)**

Thermal Type Advance Machining Processes: Classification, General principles and applications of Electro discharge, Plasma arc, Ion beam, Laser beam, Electron beam machining, Mechanics of metal removal in EDM, selection of EDM pulse generator dielectric, machining accuracy, surface finish and surface damage in EDM, Generation and control of electron beam for machining applications, advantages and limitations for employability and entrepreneurship skills.

UNIT IV **(08 Sessions)**

Chemical and Electro-chemical Type Metal Removal Processes: Principle, working advantages, disadvantages and applications of Electrochemical, Chemical machining, Economy aspects of ECM, Electro-chemical deburring and honing for employability and skill development.

UNIT V **(08 Sessions)**

Hybrid Unconventional Machining Processes: Introduction to ECDM, ECAM, and Abrasive EDM etc.to develop entrepreneurship skills

Course Outcomes: Students completing this course will be able to:

CO1: Understand the is manufacturing processes and need of nontraditional manufacturing process, and ultrasonic machining process for employability and skill development.
CO2: Understand the various non-tradational machining processes like Abrasive machining and its applications, water jet machining and its principles, Material removal rate and Electro chemical grinding, honing for skill development and employability gaining national and international interest.
CO3: Student will be gaining knowledge on Electro chemical machining process and constraints of the EDM process and its applications for employability and entrepreneurship skills.
CO4: Understand the WEDM Process and its applications of the ECM Process. Thermal processes and laser beam for employability and skill development and develops local and global interest.
CO5: Understand the Plasma machining process and its metal removal mechanism, Chemical machining processes, Magnetic abrasive machining, Electro steam drilling to develop entrepreneurship skills

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	3	3	3	3	2	1	2	3
CO 2	3	1	3	3	2	1	3	2	1	1
CO 3	1	3	3	2	1	3	1	1	2	2
CO 4	3	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	2	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	1	1
CO 2	1	3	1
CO 3	3	3	1
CO 4	2	1	3
CO 5	3	3	1

Suggested Readings:

1. Advance Machining Processes V.K. Jain New Age
2. Modern Machining Processes P.C. Pandey New Age
3. Manufacturing Processes Degarmo
4. Manufacturing Processes Kalpakjian Tata McGraw-Hill International

Website sources:

- nptel.ac.in/course.html
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TMME 120: ENTERPRISE RESOURCE PLANNING

Objective: The objective of this course is to understand the role of Enterprise Resource Planning in business planning activities. This subject exposes students on the influences of enterprise resource planning in a manner of companies conduct business and how they plan and manage the resources. The objective of the enterprise resource planning is to modernize and integrate business processes and systems for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

Introduction of Entrepreneurship: Meaning, definition and functions of an entrepreneur ,qualities of a good entrepreneur; Role of Entrepreneur in economic development; Government measures for the promotion of small scale industries with special reference to Haryana; Cultural factors in developing entrepreneurship to develop entrepreneurship skills.

Unit II **(06 Sessions)**

Owner ship and Location of Industrial Units: Different forms of Industrial Organization, Theories of Industrial location, Process of preparing project reports for employability and skill development.

Unit III **(08 Sessions)**

Size of Firm and Pricing: Concept of optimum firm, factors determining, Optimum size, Technical, Managerial, Marketing, Uncertainties and risk, Pricing Methods, Policies and procedures for skill development and employability.

Unit IV **(08 Sessions)**

Financing of Small Industries: Importance and need: Commercial Banks and term lending in India; Banks and under-writing of capital issues; Brief description about the role of other financial agencies viz; Industrial Finance Corporation of India. State, Financial Corporation, Industrial Development Bank of India and Unit Trust of India for skill development and employability.

Unit V **(10 Sessions)**

Problems Faced by Small Enterprises: problems connected with Marketing, Management of New Products; Power; Finance; Raw Material; Under-utilization of capacity; Causes of under– utilization; Rehabilitation of Sick Mills. Government and Business: Highlights of Industrial Policy and Licensing Policy. International Marketing with special reference to export documentation for employability and entrepreneurship skills.

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

CO1: Understand and apply the basics of enterprise resources and its role in enabling business strategy to develop entrepreneurship skills.
CO2: Gaining national and international interest by applying and understanding the different forms of industrial organization, TheoriesofIndustriallocation, Processofpreparingprojectreports for employability and skill development.
CO3: Analyze and apply the working knowledge of the fundamental technology and principles underlying the development, implementation, and use of integrated enterprise information systems for skill development and employability.
CO4: Ability to identify the components of ERP systems chose an ERP System, identify ERP implementation issues, and determine how ERP systems should be managed forskill development and employability.
CO5: Understanding of the problems faced by small scale industries for employability and entrepreneurship skills.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	1	3	1	2	2	2	3
CO 2	2	1	3	3	2	1	2	2	1	1
CO 3	1	3	3	2	2	3	3	1	2	2
CO 4	3	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	2	1	3
CO 2	3	3	1
CO 3	3	3	1
CO 4	3	3	2
CO 5	1	3	3

Suggested Readings:

1. DeshpandeManoharD.,EntrepreneurshipofSmallScaleIndustries,AsianPublishers,NewDelhi
2. TandonB.C., Environment and Entrepreneur, Asian Publishers, NewDelhi.
3. KuchhalS.C., The Industrial Economy of India, Chaitanya, Allahabad.
4. SinghP.Narendra,EmergingTrendsinEntrepreneurshipDevelopmentTheories&Practices,InternationalFo under,New Delhi
5. Bhattacharya Hrisnikes, Entrepreneur, Banker & Small Scale Industries.
6. RaoGangadharaN.,Entrepreneurship&GrowthofEnterpriseinIndustrialEstates

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TMME121: ADVANCED COMPUTER AIDED DESIGN

Objective: Acquire extended fundamentals and knowledge in order to use the different advance CAD systems according to the drawing, design or project to produce or model for entrepreneurship and skill development and employability.

Unit I **(06 Sessions)**

Introduction and Review of CAD: Introduction, Graphics Hardware input, display and output devices, Software configuration and functions, Graphics standards for skill development and employability.

Output Primitives: Bresenham's Circle and Ellipse generating algorithms, problems for skill development and employability

Unit II **(08 Sessions)**

Three Dimensional Transformations: Three Dimensional Geometric Transformations, multiple transformation, Rotation about an arbitrary axis in space, Parallel projections–Matrix equations for Orthographic, Oblique and Axonometric projections, Perspective transformations, equation for one point perspective projections, Stereographic projection for employability and entrepreneurship skills.

Unit III **(10 Sessions)**

Curves: Parametric representation of plane curves, space curves, Hermite curves, Bezier curves-generation and properties, B-spline curves-generation and properties, uniform, open uniform and non uniform B-splines, Rational B-spline curves for employability and skill development.

Unit IV **(08 Sessions)**

Surface Description and Generation: Parametric representation, Surfaces of revolution, Sweep surfaces, Bilinear surface, Ruled and developable surfaces, Coons bicubic surfaces, Bezier and B-spline surfaces to develop entrepreneurship skills.

Unit V **(08 Sessions)**

3D Graphics: Polygon mesh generation, Wire frame and Solid models; Sweep, Boundary and Constructive SolidGeometry of solid modeling, Problems for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of CAD software and functions, Graphics standards for skilldevelopment and employability gaining national and international interest.

CO2: Analyze and apply the concept of the drawing in different co-ordinate system, which gives the freedom to the students to work with global system for employability and entrepreneurship skills.

CO3: Apply theoretical and experimental techniques for make the different surfaces and patches using mathematics and programming of different curves for employability and skill development.

CO4: Apply theoretical and experimental techniques for make the different surfaces and developable surfaces to develop entrepreneurship skills.

CO5: Analyze and apply the data between CAD and CAM using various interfaces of 3D graphics for employability and entrepreneurship skills and develops local and global interest.

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CO 2	2	1	3	3	2	1	2	2	1	1
CO 3	1	3	3	2	2	3	3	1	2	2
CO 4	3	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	3
CO 2	2	3	3
CO 3	3	3	1
CO 4	2	1	3
CO 5	1	3	3

Suggested Readings:

1. Computer Graphics D Hearn & M P Baker Prentice Hall
2. CAD/CAM Theory and Practice Ibrahim Zeid& R Siva Subramanian Tata McGraw-Hill
3. CAD/CAM Principles and Applications P N Rao Tata McGraw-Hill
4. Computer Aided Engineering Design A Saxena and B Sahay Anamya Publications
5. Mathematical Elements for Comp. Graphics D F Rogers and J A Adams McGraw-Hill International
6. CAD/CAM H P Groover and E W Zimmers Prentice Hall

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- www.researchgate.net
- www.sanfoundry.com

Note: Latest editions of all the suggested readings must be used.

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TMME 122: ADVANCED MACHINE DESIGN

Objective: The objective of this course is to familiarize the students to gain insight about how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components and to illustrate to students the variety of mechanical components available and emphasize the need to continue learning for entrepreneurship and skill development and employability.

UNIT I **(08 Sessions)**
Design of Machine, Component with stress concentration, Concept of Stress and Strain, Factor of Safety and Reliability for employability and skill development.

UNIT II **(08 Sessions)**
Design of Non Metallic material: Like Plastic, Composite Material, Ceramic and Elastomers for employability and skill development.

UNIT III **(08 Sessions)**
Fatigue Strength, reduction factor, cracking design against fatigue Statistical analysis log design against Creep and Creep rapture, Strength, Creep Testing, Accelerated creep curve for employability and skill development.

UNIT IV **(08 Sessions)**
Design against Impact. Thermal Stress, Concept of large deflectionfor employability and entrepreneurship skills.

UNIT V **(08 Sessions)**
Design simple cantilever beam, Effect of corrosion and stress concentrationfor skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Gaining national and international interest by understanding and applying the principles of design of machine, Factor of Safety and Reliability for employability and skill development.
CO2: Analyze and apply the design of Non Metallic material: Like Plastic, Composite Material, and Ceramic for employability and skill development.
CO3: Apply the fatigue strength, creep, Creep rapture, Strength, Creep Testing, Accelerated creep curvefor employability and skill development.
CO4: Understand the design against Impact. Thermal Stress, Concept of large deflectionfor employability and entrepreneurship skills and develops local and global interest.
CO5: Understand the design simple cantilever beam, Effect of corrosion and stress concentrationfor skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	1	3	1	2	2	2	3
CO 2	2	1	3	3	2	1	2	2	1	1
CO 3	1	3	3	2	2	3	3	1	2	2
CO 4	3	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	3	1
CO 3	3	3	2
CO 4	2	3	3
CO 5	3	3	1

Suggested Readings:

1. Failure of Materials in Mechanical Design J. A. Collens John Wiley & Sons
2. Metal Fatigue in Engineering H.O. Fuchs John Wiley & Sons
3. Engineering Materials: Polymers, Ceramics and Composites A. K Bhargava Prentice Hall of India

Website sources:

- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

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TMME123: FRACTURE MECHANICS

Objective: The objective of this course is to introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design to develop the ability in students to compute the stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and non linear materials. It will also expand the students' knowledge on experimental methods to determine the fracture toughness and develop the students understanding on the design principle of materials and structures using fracture mechanics approaches for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Introduction and overview: Concepts of fracture mechanics and strength of materials, Elements of solid mechanics, Elasticity and plasticity, Incremental plasticity and deformation theory for skill development and employability.

Unit II **(08 Sessions)**
Elastic crack-tip fields, Basic concepts of linear elastic fracture mechanics, Griffth's theory, stress intensity factor, Energy release rate, Plastic zone and fracture toughness, path invariant integrals and numerical approach for employability and skill development.

Unit III **(08 Sessions)**
Plastic crack-tip fields, Mode-I fields and fracture criterion, Engineering approach to plastic fracture, J-integral approaches and numerical concepts, Tearing modulus, Time dependent fracture, non-linear aspects of fatigue crack growth, Theoretical models, Fatigue cracks in welds, standard tests and testing procedures for skill development and employability.

Unit IV **(08 Sessions)**
Brittle fracture of welded structures, Notch toughness, weld cracks and joint restrains, Weld defects and service behaviour, Application of fracture mechanics concepts and limitations for develop entrepreneurship skills.

UNIT V **(08 Sessions)**
Weld cracking tests and elimination of joint restraints, Residual stress and its interaction in fracture behavior, Numerical approaches for estimation of fracture parameters for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept of fracture mechanics and strength of materials, Elasticity, plasticity and deformation theory for skill development and employability gaining national and international interest.
CO2: Analyze and apply the concept of elastic fracture mechanics, fracture toughness, path invariant integrals and numerical approach for employability and skill development.
CO3: Analyze and apply the concept of Plastic crack-tip fields, Engineering approach to plastic fracture, numerical concepts, Theoretical models, Fatigue cracks in welds, standard tests and testing procedures for skill development and employability.
CO4: To apply the fracture of welded structures, Notch toughness, weld cracks and joint restrains, Weld defects and service behavior, for develop entrepreneurship and develops local and global interest.
CO5: To control and develop Weld cracking tests and elimination of joint restraints, Residual stress and its interaction in fracture behavior, Numerical approaches for estimation of fracture parameters for employability and entrepreneurship skills.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	1	3	1	2	2	2	3
CO 2	2	1	3	3	2	1	2	2	1	1
CO 3	1	3	3	2	2	3	3	1	2	2
CO 4	3	2	3	1	2	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	3	1
CO 3	3	3	2
CO 4	2	1	3
CO 5	1	3	3

Suggested Readings:

1. Khanna O.P.: Industrial Engineering
2. Fracture Mechanics: Fundamentals and Applications Anderson, T. L CRC Press
3. Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue Dowling, Norman E Dowling Prentice Hall
4. Advanced Fracture Mechanics Kanninen, Melvin F Popelar, Carl H Oxford University Press
5. Analytical Fracture Mechanics Unger, David J Dover Publications

Website sources:

- nptel.ac.in/course.html
- en.wikipedia.org
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME201: NUMERICAL METHODS AND ANALYSIS

Objective: - The main aims of this course are to study numerical analysis to make the students familiarize with the ways of solving complicated mathematical problems with the help of numerical methods and analyze the results. To improve and analyze the results and students skills in numerical methods by using the numerical analysis software such as MATLAB and computer facilities in engineering to provide employability and skill development.

UNIT I **(08 Sessions)**

Solution of Algebraic and Transcendental Equation: Bisection Method, Method of False position, Newton-Raphson method including method of complex roots, Graeffe's root square method (Computer based algorithm and programme for these methods) for skill development and employability.

UNIT II **(08 Sessions)**

Interpolation and Approximation: Newton interpolation formula for finite differences, Gauss's forward and backward interpolation formulae, Stirling's Formula , Bessel's and Laplace-Everett's formulae, Lagrange's and Newton-divided difference formula, Cubic spline, Least squares approximation using Chebyshev polynomial for skill development and employability.

UNIT III **(08 Sessions)**

Solution of Linear Simultaneous Equations: Cholesky's (Crout's) method, Gauss-Seidel iteration and relaxation methods, Solution of Eigen value problems; Smallest, Largest and intermediate Eigen values (Computer based algorithm and programme for these methods)for skill development and employability.

UNIT IV **(08 Sessions)**

Numerical Differentiation and Integration: Numerical differentiation using difference operators, Trapezoidal Rule, Simpson's 1/3 and 3/8 rules, Boole's rule, Weddle's rule for skill development and employability.

UNIT V **(08 Sessions)**

Solution of Differential Equations: Modified Euler's method, Runge-Kutta method of 2nd, 3rd and 4th orders, Predictor- Corrector method, Stability of ordinary differential equation, Solution of Laplace's and Poisson's equations by Liebmann's method, Relaxation method for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Apply Numerical analysis which has enormous application in the field of Science and different fields of Engineering for skill development and employability.
CO2: Familiar with numerical solutions of nonlinear equations in a single variablefor skill development and employability gaining national and international interest.
CO3: Familiar with numerical integration and differentiation, numerical solution of ordinary differential equations for skill development and employability.
CO4: Familiar with calculation and interpretation of errors in numerical method for skill development and employability.
CO5: Familiar with programming with numerical packages like MATLAB for skill development and employability and develops local and global interest.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	3	3	3	3	3	3	2	2	3
CO 2	2	1	3	3	2	1	1	3	1	1
CO 3	1	2	2	3	2	1	1	1	2	2
CO 4	2	2	3	1	2	1	2	1	1	2
CO 5	1	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	3	1
CO 3	3	3	1
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Numerical Method for Scientific and Engineering Computation M.K. Jain, S.R.K. Iyenger and R.K. Jain Wiley Eastern Ltd.
2. Numerical Methods for Engineers S.K. Gupta Wiley Eastern Ltd.
3. Numerical Methods B. S. Grewal Khanna Publications
4. Numerical Methods A.D. Booth Academic Press, NY
5. An Introduction to Numerical Analysis K.E. Atkinson John Wiley & Sons, NY.

Website Sources:

- www.pdfdrive.com
- www.dmi.gov.in
- www.yourarticlelibrary.com
- onlinecourses.nptel.ac.in
- en.wikipedia.org

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TMME202: ADVANCED MECHANICS OF SOLIDS

Objective: The objective of this course is to present the mathematical and physical principles in understanding the linear continuum behavior of solids under different loading conditions to provide employability, skill development and entrepreneurship development.

UNIT I **(08 Sessions)**
Analysis of stress and strain. Constitutive relationships and failure theories. Plane stress and plane strain problems for skill development and employability.

UNIT II **(08 Sessions)**
Torsion, Torsion of non-circular sections, review of fatigue analysis for skill development and employability.

UNIT III **(08 Sessions)**
Introduction to fracture mechanics for skill development and employability

UNIT IV **(08 Sessions)**
Inelastic behavior, Visco-elasticity, Structure and behavior of polymers for skill development and employability.

UNIT V **(08 Sessions)**
Behavior of unidirectional composites and orthotropic lamina, Failure theories for fiber composites, development of various structures in composites. Computer based analysis and solutions to problems in mechanics of solids for skill development, employability and entrepreneurship development.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concepts of stress and strain at a point, stress-strain relationships and failure theories and use this knowledge for skill development and employability.
CO2: Gaining national and international interest by understanding the behavior of shafts under torsion and review of fatigue analysis for skill development and employability.
CO3: Analyzing fracture mechanics for skill development and employability.
CO4: Analyzing inelastic behavior and behavior of polymers for skill development and employability and develops local and global interest.
CO5: Evaluating computer based analysis and solutions to problems in mechanics of solids for skill development, employability and entrepreneurship development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	1	2	1	2	2
CO2	2	2	3	1	2	1	2	1	1	2
CO3	1	3	2	3	3	2	1	2	3	3
CO4	2	2	3	1	3	1	2	3	1	2
CO5	1	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	3	3	1
CO3	3	3	2
CO4	3	3	1
CO5	3	3	3

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Suggested Readings:

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill, 2008.
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill, 2008.
3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services, 2013.
4. S. P. Timoshenko and J. N. Goodier, Theory of elasticity, McGraw Hill, 1970.
5. R. J. Atkin and N. Fox, An introduction: The theory of elasticity, Longman, 1980.
6. J. P. D. Hartog, Advanced Strength of Materials, McGraw Hill, 1987.
7. C. K. Wang, Applied Elasticity, McGraw Hill, 1983.

Website Sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

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TMME203: COMBUSTION ENGINEERING

Objective: To build up knowledge of the concepts and theories of a of classical fuel combustion and develop the understanding of the basic principles and concepts of advanced fuel combustion and control process. Also To provide students with the required skills, for analyzing thermal cycles, and make them familiar with the fundamental physical and chemical principles regarding formation and control of air pollutants in industrial and technological processes to provide employability, skill development and entrepreneurship development.

UNIT I **(08 Sessions)**

Introduction: Importance of combustion; Combustion equipment's, Hostile fire problems, pollution problems arising from combustion.

Thermodynamics of Combustion: Enthalpy of formation; Enthalpy of reaction; Heating values; First & second laws; Analysis of reaction system, Chemical equilibrium, Equilibrium composition; Adiabatic & equilibrium, Flame
Temperature for skill development and entrepreneurship.

UNIT II **(08 Sessions)**

Kinetics of Combustion: Law of mass action; Reacting rate; Simple and complex reaction; Reaction order & molecularity, Arhenius laws; Activation Energy; Chain reaction; Steady rate & Partial equilibrium approximation; chain explosion; Explosion limit and oxidation characteristics of hydrogen, Carbon monoxide, Hydrocarbons for skill development.

UNIT III **(08 Sessions)**

Flames: Remixed flame structure & propagation of flames in homogeneous mixtures; Simplified Rankine Hugoniot relation, Properties of Hugoniot curve, Properties of Chapmen Jouguet wave, Laminar flame structure; Theories of flame propagation & calculation of flame speed measurements. Stability limits of laminar flames; Flammability limits & quenching distant, Mechanism of flame stabilization in laminar & turbulent flows, Flame quenching, Diffusion flames; Comparison of diffusion with premixed flame, combustion of gaseous fuel, jets burke & Schumann development for skill development and employability.

UNIT IV **(08 Sessions)**

Burning of Condensed Phase: General mass burning considerations, Combustion of fuels droplet in a quiescent and convective environment, Introduction to combustion of fuel sprays.

Ignition: Concept of ignition, Chain ignition, Thermal spontaneous ignition, Forced ignition for skill development.

UNIT V **(08 Sessions)**

Combustion Generated Pollution & its Control: Introduction, Nitrogen oxide, Thermal fixation of atmospheric nitrogen prompts, NO, Thermal NOx & control in combustors. Fuel NOx & control, post combustion destruction of NOx, Nitrogen dioxide, carbon monoxide Oxidation-Quenching, Hydrocarbons, Sulphur oxide for skill development.

Course Outcomes: Students completing this course will be able to:

CO1: Recognize and understand reasons for differences among operating characteristics of different engine types and designs for skill development & entrepreneurship.
CO2: Differentiate among different internal combustion engine designs for skill development gaining national and international interest.
CO3: Develop an understanding of real world engine design issues for skill development and employability.
CO4: Develop an ability to optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions) for skill development.
CO5: Develops local and global interest by understanding pollution generation and adaptive ways to control it for skill development.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	1	2	2	2	2
CO2	1	3	2	3	3	2	3	2	3	3
CO3	1	1	2	3	3	2	1	2	2	3
CO4	2	3	1	2	3	3	2	3	1	2
CO5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	1	3
CO2	3	1	1
CO3	3	3	1
CO4	3	1	1
CO5	3	2	1

Suggested Readings:

1. Internal Combustion Engines: Applied Thermo sciences Ferguson Colin R John Wiley
2. Engineering Fundamentals of the Internal Combustion Engine Pulkrabek Pearson Education India
3. Instrumentation for Combustion and Flow in Engines Durao D F G Kluwer Aca
4. Energy From Biomass: A Review of Combustion and Gasification Technologies Quaak Peter

Website Sources:

- ocw.mit.edu/courses/mechanical-engineering
- www.cambridgescholars.com
- www.accessengineeringlibrary.com
- www.aiche.org/resources

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TMME211: INDUSTRIAL AUTOMATION & ROBOTICS

Objective: Introduction to the concept of industrial automation, scope of automation and study of socio-economic effects. Introduction to the fluid power control and study of the different fluid power systems working. Introduction to the automated material handling system used in automated industry. Study of the working principle mechatronics devices and different types of controllers, Introduction to the control systems.

Unit I **(08 Sessions)**

Introduction to Automation: Mechanization and automation, Types of automation, Automation strategies, Hard Automation and Soft Automation, Economics of automation, Socio economic aspects of automation for skill development & employability.

Unit II **(08 Sessions)**

Manufacturing Automation: Classification and types of Manufacturing Automation, Scenario of Automation and Factory Configuration, Shop Floor Control, MAP/TOP, AS/RS for skill development & employability.
AGV- Components Functions and Benefits, Traffic Controls and Safety, Cost Justification and Applications for skill development & entrepreneurship.

Unit III **(08 Sessions)**

Robotics: Robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot classification, Physical Configuration and Work Volume, Robotic Motions, Functional Parameters, revolution accuracy and repeatability, End Effectors, Robot kinematics, Homogeneous transformation, Direct and inverse kinematics, Manipulator motions, Robot drives, actuators and control for skill development & entrepreneurship.

Unit IV **(08 Sessions)**

Robot motion and path planning control and Controllers, Robotic sensors and Robot vision, Image representation, Image recognition approaches for skill development & entrepreneurship.

Unit V **(08 Sessions)**

Robot Applications: Robot Capabilities, Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics, Future applications.
Implementation Principles, Maintenance & Safety, Robotic Education for skill development & employability.

Course Outcomes: Students completing this course will be able to:

CO1: Knowledge regarding key components and functioning of an automated industry for skill development & employability gaining national and international interest.
CO2: Knowledge regarding the working of elements such as hydraulic generator, hydraulic & pneumatic actuator, hydraulic &pneumatic valves used in heavy construction equipment for skill development & employability.
CO3: Understand about the Robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot classification for skill development & entrepreneurship.
CO4: Knowledge regarding the functioning of Robotic systems such as motors, controllers, converters etc. for skill development & entrepreneurship.
CO5: Ability to understand the robot application, robot capabilities in manufacturing industry for skill development & employability and develops local and global interest.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	1	2	2	2	2
CO2	1	3	2	3	3	2	3	2	3	3
CO3	1	1	2	3	3	2	1	2	2	3
CO4	2	3	1	2	3	3	2	3	1	2
CO5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	3	3	1
CO3	3	2	3
CO4	3	1	3
CO5	3	3	1

Suggested Readings:

1. Groover,Automation,ProductionSystem&ComputerIntegratedManufacturing,PrenticeHallIndia
2. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Robotics, McGraw Hill.
3. J. J. Craig, Robotics, Addison- Wesely
4. R. D. Klafter, T.A. Chmielewski and M. Negin, Robot Engineering: An Integrated Approach, Prentice Hall India.
5. Matthew T. Mason, Mechanics of robotic manipulation, Prentice Hall of India, 2005.
6. KumarSurender,"IndustrialRobotsandComputerIntegratedManufacturing",Oxfo rd&IBHPublishing Co., New Delhi.

Website Sources:

- ocw.mit.edu/courses/mechanical-engineering
- www.cambridgescholars.com
- www.accessengineeringlibrary.com
- www.aiche.org/resources

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TMME212: ADVANCED MECHANICAL VIBRATIONS

Objective: Fully understand and appreciate the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions. Be able to obtain linear and non-linear vibratory models of dynamic systems with changing complexities (Single and Multi Degree of Freedom Systems, Continuous Systems.). Be able to do Solve Vibration models for free, damped and forced (harmonic, periodic and non-periodic excitation) condition. To help the design process for better comfort of customer for entrepreneurship and skill development and employability.

Unit I **(06 Sessions)**

Introduction: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations for skill development and entrepreneurship.

Unit II **(08 Sessions)**

Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation for entrepreneurship and employability.

Unit III **(09 Sessions)**

Multi-degree Freedom systems: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamentalfrequency-Rayleigh's,Dunkerely,StodolaandHolzermethodfor skill development and employability.

Unit IV **(09 Sessions)**

Method of matrix iteration, Finite element method for close coupled and far coupled systems to entrepreneurship and skill development.

Unit V **(08 Sessions)**

Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars. Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum. Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, application and scope of engineering vibration in mechanical design of machine parts and related problems for skill development and entrepreneurship gaining national and international interest.
CO2: Be able to obtain linear and non-linear vibratory models of single and multi-degree of Freedom Systems with changing complexities for entrepreneurship and employability.
CO3: Be able to perform modal analysis for linear and non-linear vibratory models of dynamic systems for skill development and employability.
CO4: Be able to do Solve Vibration models for free, damped and forced (harmonic, periodic and non-periodic excitation) condition to gain entrepreneurship techniques and skill development and develops local and global interest.
CO5: To help the design process for better comfort of customer for entrepreneurship and skill development and employability.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	2	3	3
CO 3	3	3	1
CO 4	3	2	3
CO 5	3	3	3

Suggested Readings:

1. J.S. Raoand K. Gupta, Theory and practice of Mechanical Vibrations, New Age International
2. G. K. Groover, Mechanical Vibrations, Nem Chand & Brothers
3. V. Ramamurti, Mechanical Vibration Practice, Narosa Publications
4. V P. Singh, Mechanical Vibrations, Dhanpat Rai & sons
5. R.V. Dukkipati& J. Srinivas, Text book of Mechanical Vibrations, Prentice Hall of India

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

Note: Latest editions of all the suggested readings must be used.

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TMME213: SUPPLY CHAIN MANAGEMENT

Objective: Supply chain management is concerned with the efficient integration of suppliers, factories, warehouses and stores so that merchandise is produced and distributed: – In the right quantities – To the right locations – At the right time. In order to – Minimize total system cost – Satisfy customer service requirements – face global competition –Improve standardization for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Role of Supply Chain Management, Scope and Importance: Historical evolution of SCM, Supply Chain components: In bound logistics, Operations for entrepreneurship and skill development.

Unit II **(08 Sessions)**
Out bound logistics, Forecasting, Inventory strategy, Transportation Strategy, Warehouse management. Information Strategy for SCM to skill development and employability.

Unit III **(08 Sessions)**
Customer driver Strategies: Logistics and Competitive Strategy, System View, Co-ordination and Management of Transportation, Inventory, Order Processing, Purchasing, Warehousing, Materials Handling, Packaging employability and entrepreneurship skills.

Unit IV **(08 Sessions)**
Customer Service Management. Marketing and Supply Chain Interface finance and supply Chain Interface. Distribution Policies and Plans.Information Systems .Role of Information Technology in SCM, Performance measurement, Organization design and structure for effective supply chain to enhance employability and skill development.

Unit V **(08 Sessions)**
Decision Support Models of Supply Chain Management: Transportation Systems. Warehouse Design, Distribution Policies, Transshipment. etc. for entrepreneurship skills and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept of supply chain management and its efficient integration with suppliers, factories, warehouses and stores for entrepreneurship and skill development.
CO2: Gaining national and international interest to create activities in the supply chain that transcends the activities of particular entities in the chain of different industrial configurations to skill development and employability.
CO3: Managing supply chain and balancing act among competing interests to facilitate employability and entrepreneurship skills.
CO4: Add value for customers and stakeholders, improve customer service, and effectively use system wide resources for enhancing employability and introduction to information system for skill development.
CO5: To understand decision support models of supply chain management gaining insight for entrepreneurship skills and employability and develops local and global interest.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	3	1	2	3	3	2	1	2	2	3
CO 4	2	2	3	2	3	2	3	3	1	2
CO 5	3	2	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	2	3
CO 2	3	3	1
CO 3	1	3	3
CO 4	3	3	1
CO 5	2	3	3

Suggested Readings:

1. SunilChopra,PeterMeindlandD.V.Kalara,SupplyChainManagement,Strategy,PlanningandOperation,PearsonEducationInc,2007
2. RonaldH.Ballou,BusinessLogisticsManagement,PrenticeHallMohanty.R.P,Deshmukh.S.G.,SupplychainManagement, Phoenix publishing, American Society of Phoenix publishing
3. B. Sahay, Integrated supply chain management
4. B. C Sahay, Emerging issues in supply chain management, Macmillan, India

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME214: HEAT TREATMENT PROCESSES

Objective: To provide through knowledge of heat treatment processes for metals. To understand the requirement of heat treatment process at various stage of material from raw material to finished product. To understand how the properties of the metals change after teat treatment process for providing employability, skill development and entrepreneurship development.

UNIT I **(06 Sessions)**

Introduction: Nature and alloys; Heat treatment process, Requirements, Theory, Advantages, Process variables for their skill development and employability.

UNIT II **(10 Sessions)**

Heat Treatment of Ferrous Metals: Iron Carbon phase diagram; TTT diagram; different microstructures; transformations; Annealing, Stress relieving; Spherodizing; Normalizing; Hardening; Tempering; Austemepring; Martempering; Quenching; Quenchants; Quenching mediafor skill and entrepreneurship development.

UNIT III **(10 Sessions)**

Surface hardening; Hardenability; Sub-zero treatment; Thermo-mechanical treatment; Chemical Treatment; Tool steel and their heat treatment; cast Iron and their heat treatment for employability.

UNIT IV **(08 Sessions)**

Heat Treatment of Non-Ferrous Metals: Aluminium and its alloys; Heat treatable and non-heat-treatable aluminum alloys; Classification of heat treatment of aluminum alloys; Heat treatment of Aluminum and its alloys; Heat treatment of Magnesium and its alloys for skill development and employability.

UNIT V **(06 Sessions)**

Heat treatment of Titanium and its alloys; Heat treatment of Copper and its alloys; Heat treatment of Nickel and its alloys, Energy Economy in heat treatment for skill and employability development.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the role of heat treatment process, their requirement and how the properties of metals can be modified for their skill development and employability.
CO2: Able to select the appropriate process to modify a particular property of the ferrous metals for skill and entrepreneurship development gaining national and international interest
CO3: Be able to get employability in an industry related to manufacturing of metal products.
CO4: Be able to select the appropriate heat treatment process to modify the properties of the non-ferrous metals like aluminum and magnesium for skill development and employability and develops local and global interest.
CO5: Be able to modify the properties of titanium, copper and nickel and to utilize proper energy in heat treatment process for skill and employability development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	1	3
CO 3	1	3	1
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Principles of Heat Treatment of Steels R.C. Sharma New Age International (P)
2. Heat Treatment: Principle and Techniques T.V. Rajan, C.P. Sharma and Ashok Sharma Prentice Hall India.

Website Sources:

- nptel.ac.in
- http://www.springer.com
- https://www.slideshare.net/fellowbuddy/heat-treatment-61493702
- https://www.vssut.ac.in/lecture_notes/lecture1428553162.pdf
- www.utube.com

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TMME215: DESIGN OF PRODUCTION TOOLING

Objective: Introduction to the concept of Jig and Fixtures, Types and applications, principle of design and constructions, Location and Clamping, Design of turning, milling, drilling & indexing, Hydraulic, Pneumatic and Pneumo hydraulic devices for Jigs and Fixtures. Concept of press work, Punch and die clearance, Centre of pressure with calculation of blank diameter. Introduction of Dies for metal powder performs, design considerations, Basic models of flow & perform design. Concept of design of various types of tools for production of holes, surface of revolution and flat surface. Materials for cutting tools, cutting dies and forming dies. Introduction of Economics of Tooling and special features of Plastic as a tooling material for entrepreneurship and skill development and employability.

Unit I **(06 Sessions)**
Jigs & Fixtures: Types and applications. Principle of design and constructions, Location and clamping for employability and skill development.

Unit II **(08 Sessions)**
Design of turning, Milling, Drilling & Indexing Jigs and fixtures.Hydraulic, Pneumatic and pneumohydraulic devices for jigs and fixtures to develop employability and entrepreneurship skills.

Unit III **(10 Sessions)**
Press Dies: Classification of dies, components of dies assembly, Simple dies, compound dies, combination dies and progressive dies.
Punch and die clearance, centre of pressure, calculation of blank diameter. Design of cutting dies, forming dies and progressive dies.
Dies for metal powder performs, design considerations, Basic models of flow & perform design for employability and entrepreneurship skills.

Unit IV **(10 Sessions)**
Cutting Tools: Design of tools for the production of holes, surfaces of revolution, and flat surfaces like single point tools, form tools, drills, milling cutters enhancing employability and skills development..

Unit V **(06 Sessions)**
Materials for cutting tools, cutting dies and forming dies, Economics of Tooling. Plastics as a tooling material for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and design aspects of jigs and fixtures for employability and skill development.
CO2: Gaining national and international interest understanding the design aspects of jigs and fixtures for turning, milling and indexing to develop employability entrepreneurship skills.
CO3: Facilitate employability and entrepreneurship skills by understanding the construction and working of press dies and terminology associated with it.
CO4: Analyze the design aspects of cutting tools for the production of holes and other surfaces to enhance employability and skills development and develops local and global interest.
CO5: To gain in sight of various materials used for cutting tools, cutting dies and forming dies for skills development and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	2	3	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Umesh Chandra &Surender Kumar, Production Engineering Design (Tool Design), Satya Prakashan, New Delhi
2. C. Donaldson G. H. Lecain and V. C. Goold, Tool Design, Tata McGraw Hill
3. Osterguard E, Basic Die Making, McGraw Hill Book Co
4. V. Arshinov, Metal Cutting & Tool Design, Mir Publication
5. Kortesoja, Victor A., Properties and Selection of Tool Material, ASM

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME216: MACHINE TOOL DESIGN

Objective: The objective of machine tool design is to reduce the overall cost of manufacturing a product by producing acceptable parts at lowest cost and increase the production rate by designing tools that will produce parts as quickly as possible. Maintain quality by designing tools which will consistently produce parts with the required precision. Reduce the cost of special tooling by making every design as cost effective and efficient as possible for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Working and auxiliary motions in machine tools, hydraulic and mechanical transmission, transforming rotary motion into translator motion, reversing and differential mechanisms, machine tool design process for skill development and employability.

Unit II **(08 Sessions)**
Regulation of speed and feed rates, Stepped and step less regulations, classification and design of speed and feed boxes, structure diagram, speed chart and gearing diagram for employability and entrepreneurship skills.

Unit III **(08 Sessions)**
Criteria and design requirements of machine tool structure, material selection, machine tool structure profiles, stiffness and compliance. Design procedure for beds, columns, housings and tables. Concept of dimension chain in design of machine tools todevelop entrepreneurship skills.

Unit IV **(08 Sessions)**
Design of guide ways; function and type of guideways/slideways, design criteria and material selection, Tribology of guide ways; design of spindle and spindle supports, stability analysis, dynamics of machine tools for employability and entrepreneurship skills.

Unit V **(08 Sessions)**
Control systems and its functions for machine tools, requirement and selection of control systems, ergonomic considerations.
Design aspects of conventional machine tools and case studies to develop entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Apply cutting mechanics to metal machining based on cutting force and power consumption for skill development and employability.
CO2: To apply selected cutting tool materials and tool geometries for different metalsfor employability and entrepreneurship skills gaining national and international interest.
CO3: Analyze the design procedure for beds, columns, housings and tables. Concept of dimension chain in design of machine tools to develop entrepreneurship skills.
CO4: To develop fundamental knowledge on tool materials, cutting fluids, tool wear mechanisms and importance of metal cutting parameters for employability and entrepreneurship skills.
CO5: To apply knowledge of basic Control systems and its functions for machine tools, requirement for different machining processes, Designaspectsofconventionalmachinetoolsandcasestudies to develop entrepreneurship skills and develops local and global interest.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	2	3	2	3	2	3	2	3
CO 2	3	1	1	3	2	1	3	2	1	1
CO 3	1	2	3	2	2	3	3	1	2	2
CO 4	3	2	2	1	3	1	2	1	1	2
CO 5	1	3	1	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	1	3	3
CO 3	2	1	3
CO 4	2	3	3
CO 5	1	2	3

Suggested Readings:

1. MehtaN.K.,MachineToolDesign,TataMcGralHill,PublishingCo.,NewDelhi
2. Basu S. K., Design of Machine Tools, Allied Publishers, New Delhi.
3. Koenisberger, F., Design of Metal Cutting Machine Tools, Pergamon Press, Oxford, U.K.
4. Bhattacharya,A.&Sen,G.C.,PrinciplesofMachineTools,NewCentralBookAgency,Kolkata.
5. Acherkan, N., Machine Tool Design, Vol-I-IV, Mir Publishers, Moscow.

Website sources:

- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com
- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com

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TMME217: PRODUCT DESIGN AND DEVELOPMENT

Objective: The objective of this course is to familiarize the students to gain insight about use of modern product development processes and the concept of Industrial design and robust design. Understand the concept of Design for manufacture and assembly and the legal factors, social issues, engineering ethics related to product design. Prepare primary designs taking into consideration ergonomics and aesthetic aspects of the product and understand the concept of Concurrent engineering, rapid prototyping for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Introduction, Sources of new ideas, Development processes, Product planning, Identification for Customer needs and technology potentials, Innovation and intellectual property rights, Product and process Patents, Patents and patenting processes for employability and skill development.

Unit II **(08 Sessions)**
Product specifications, Tolerance specifications, Taguchi loss factor concepts, Quality function deployment, Functional specifications of products, Form and function, Development of alternatives to develop skills and entrepreneurship.

Unit III **(08 Sessions)**
Design for manufacture, Design for Assembly and design for economy, Prototyping and analytical prototyping, Stage-gate process of product development for employability and entrepreneurship skills.

Unit IV **(08 Sessions)**
Holistic product development approaches-Form product concept to decommissioning, Environment requirements, Life cycle design, Product data management and Product life cycle management systems enhancing employability and skills development.

Unit V **(08 Sessions)**
Dependency and concurrent engineering in development of products. Internet based approach to product development involving users. Democratization of innovation, Connecting products to services, Experience innovation, Robust design, Patents and Intellectual properties, product Developments for employability and skills development.

Course Outcomes: Students completing this course will be able to:
CO1: Understand modern product development processes, customer need, patents for employability and skill development gaining national and international interest.
CO2: Understand and explain the concept of Industrial design and robust design concepts to develop skills and entrepreneurship.
CO3: Understand the concept of Design for manufacture and assembly for employability and entrepreneurship skills.
CO4: Understand the legal factors, social issues, engineering ethics related to product design enhancing employability and skills development and develops local and global interest.
CO5: Prepare primary designs taking into consideration ergonomics and aesthetic aspects of the product. Understand the concept of Concurrent engineering, rapid prototyping for skills development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	2

Suggested Readings:

1. Production Management K K Ahuja CBS Publishers
2. Production Design and Manufacturing A. K. Chitale& A. K. Gupta Prentice Hall of India
3. Management Development Alan Mumford Jaico Publishing House

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
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TMME218: INDUSTRIAL DESIGN &ERGONOMICS

Objective: The objective of this course is to familiarize the students to gain insight about structure for industrial design in engineering, approach to the man-machine relationship, work station design, working position and explain the concept of controls and displays for machine tools , automobiles etc. Apply the concept of ergonomics in automated systems and the visual effects of line and colour. Prepare primary designs taking into consideration ergonomics and aesthetic aspects of the industrial design in design process for entrepreneurship and skill development and employability.

Unit I **(06 Sessions)**

Introduction to Ergonomics and Industrial Design: An approach to industrial design- elements of design, Structure for industrial design in engineering; Application in modern manufacturing systems; General approach to the man-machine relationship, Work station design, Working position for employability and skill development.

Unit II **(08 Sessions)**

Control and Displays: Shapes and sizes of various controls and displays- Multiple displays and control situations; design of major controls in automobiles, machine tools etc.; Design of furniture; Redesign of instruments to develop skills and entrepreneurship.

Unit III **(08 Sessions)**

Ergonomics and Production: Ergonomics and product design, ergonomics in automated systems; Expert systems for ergonomic design; Anthropometrics data and its applications in ergonomic design; Limitations of anthropometric data, Use of computerized database; Case study for employability and entrepreneurship skills.

Unit IV **(10 Sessions)**

Visual Effects of Line and Color: The mechanics of seeing; Psychology of seeing; General influence of line and form; Colour and light; Color and objects; Color and the eye; Colour consistency; Colour terms; Reaction to colour and colour continuation; Colour on engineering equipment enhancing employability and skills development.

Unit V **(08 Sessions)**

Aesthetic Concepts: Concept of Unity; Concept of order with variety; Concept of purpose style and environment;

Aesthetic expressions; Style, Components of style; House style; Observation style in capital goods; Case study.

Industrial Design in Practice: General design; Specifying Design equipments; Rating the importance of industrial design; Industrial design in design process for skills development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Gaining national and international interest by understanding structure for industrial design in engineering,approach to the man-machine relationship, work station design, working position for employability and skill development.

CO2: Understand and explain the concept of controls and displays for machine tools, automobiles etc. to develop skills and entrepreneurship.

CO3: Understand and apply the concept of ergonomics in automated systems for employability and entrepreneurship skills.

CO4: Understand the visual effects of line and color enhancing employability and skills development.

CO5: Prepare primary designs taking into consideration ergonomics and aesthetic aspects of the industrial design in design process for skills development and employability and develops local and global interest.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	2	2	3	2	2	3	2	3	3
CO 3	1	1	2	2	2	2	1	2	2	3
CO 4	2	2	1	3	3	3	2	3	1	2
CO 5	3	3	3	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	2

Suggested Readings:

1. Industrial design for Engineers W. H. Mayall London Hiffee Books Ltd.
2. Introduction to Ergonomics R.C. Bridger McGraw Hill
3. Human Factor Engineering Sanders &McComlick

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
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TMME219: MICRO MANUFACTURING

Objective: Meso and micro manufacturing are emerging as an important technology especially in the areas where miniaturization yields economic and technical benefits, namely, aerospace, automotive, optical, biomedical and similar other areas. The basic objective of the present course is to acquaint the participants with the principles, basic machine tools, developments in the micro-manufacturing processes, micro and nano metrology and research trends in the area of micro-manufacturing processes. Thus, this course will deal with various areas of micro manufacturing which aims for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Micro Manufacturing : An Introduction. Challenges in Meso, Micro and Nano Manufacturing Micro Turning, Micromilling and Microdrilling Micro Grinding.Abrasive Jet Micromachining, Ultrasonic Micromachining, Abrasive Water Jet Micromachining for employability and skills development.

Unit II **(08 Sessions)**
Electric Discharge Micromachining, Laser Beam Micromachining, Electron Beam Micromachining. Electrochemical Micromachining to develop entrepreneurship and skills development.

Unit III **(08 Sessions)**
Micro and Nano Manufacturing by Focused Ion Beam Magneto rheological and Allied Finishing Processes Magnetic Abrasive Finishing (MAF). Abrasive Flow Finishing (AFF) to develop employability and entrepreneurship skills.

Unit IV **(08 Sessions)**
Introduction to Micro joining Laser, Micro Welding. Electron Beams Micro Welding Introduction to Micro forming Micro Extrusion. Micro Bending with Laser enhancing employability and skills development.

Unit V **(08 Sessions)**
Dimension Metrology for Micro/Meso-Scale Manufacturing Introduction to Micro molding - A Soft Lithography Technique Introduction to Fabrication of Microelectronic Devices for skills development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of micro manufacturing for employability and skills development.
CO2: Understand different types of micro machining processes to develop entrepreneurship and skills development gaining national and international interest
CO3: Facilitate employability and entrepreneurship skills by understanding the different types of advanced micro machining processes.
CO4: Analyze the mechanism and concept of micro welding, micro joining laser and other processes enhancing employability and skills development.
CO5: Understand dimension of metrology for micro/meso-scale manufacturing for skills development and employability and develops local and global interest.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	2	2	2	3	2	3	3
CO 3	3	1	3	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	2

Suggested Readings:

1. V.K. Jain, Editor, Introduction to Micro Machining, Narosa Publication House, 2010
2. M. K. Singh, Unconventional manufacturing process, New age international publisher, 2008
3. Muammerkoc, tugrulozel, Micro manufacturing design and manufacturing of micro products
4. Yi qin, Micro-manufacturing engineering and technology, Elsevier, UK, 2010

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

Note: Latest editions of all the suggested readings must be used.

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Master of Technology (M. Tech) Programme
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TMME220: CONCURRENT ENGINEERING

Objective: It refers to an approach used in product development in which functions of design engineering, manufacturing engineering and other functions are integrated to reduce the elapsed time required to bring a new product to the market. Concurrent Engineering is a systematic approach to the integrated, concurrent design of products and their related processes, including, manufacturing and support. This approach is intended to cause the developers from the very outset to consider all elements of the product life cycle, from conception to disposal, including quality, cost, schedule, and user requirements for entrepreneurship and skill development and employability.

Unit I **(10 Sessions)**

Introduction: Product development objectives and product development cycle. Background and challenges faced by modern production environment, Sequential engineering process for employability and skill development.

Concurrent engineering: Definition need and utility, Objectives of CE, Benefits of CE, Life cycle design of products, Life cycle costs for employability and skill development.

Support for CE: Classes of support for CE activity, CE organizational, Structure CE, Team composition and duties, Computer based Support, CE Implementation Process for employability and skill development.

Unit II **(06 Sessions)**

Design Product for Customer: Industrial Design, Quality Function Deployment, Translation process of quality function deployment (QFD) to develop employability and entrepreneurship skills.

Unit III **(08 Sessions)**

Modeling of Concurrent Engineering Design: Compatibility approach, Compatibility index, Implementation of the Compatibility model, Integrating the compatibility concerns to develop employability and entrepreneurship skills.

Unit IV **(08 Sessions)**

Design for Manufacture (DFM): Introduction, Role of DFM is CE, DFM methods, e.g. value engineering, DFM guidelines, Design for assembly, Creative design methods, Product family themes, Design axioms, Robust design: Taguchi design methods, Computer based approach to DFM. Evaluation of manufacturability enhancing employability and skills development.

Unit V **(08 Sessions)**

Quality by Design: Quality engineering & methodology for robust product design, parameter and Tolerance design, Quality loss function and signal to noise ratio for designing the quality, experimental approach. Design for reliability, life cycle serviceability design, design for maintainability, design for economics, decomposition in concurrent design, concurrent design case studies forskills development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of Industrial Management for employability and skill development gaining national and international interest.

CO2: An expression for the ambition to increase the competitiveness by decreasing the lead-time and still improving quality and cost to develop employability and entrepreneurship skills.

CO3: Facilitate employability and entrepreneurship skills by understanding and design modern way to develop new products.

CO4: Handle issues of high costs, product robustness, and long lead times associated with product developmentenhancing employability and skills development and develops local and global interest.

CO5: Basic knowledge of design of manufacture methods and value engineering for skills development and employability.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	2	3	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Kusiak John, Concurrent Engineering, Wiley
2. Concurrent Engineering Menon Chapman & hall
3. M.M. Anderson and L Hein, integrated Product Development, IFS Publications
4. J. Cleetus, Design for Concurrent Engineering, CE Research Centre, Morgantown
5. Prasad, Concurrent Engineering Fundamentals: Integrated Product Development, Prentice hall India

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
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TMME221: RELIABILITY, MAINTENANCE MANAGEMENT & SAFETY

Objective: The objective of this course is to familiarize the students to gain insight about the approaches and techniques to assess and improve process and/or product quality and reliability. Introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring. Illustrate the basic concepts and techniques of modern reliability engineering tools for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Optimization, Reliability – Cost trade off, Prediction and analysis, Problems for employability and skill development.

Unit II **(06 Sessions)**

Maintainability, Availability & Failure Analysis: Maintainability & Availability – Introduction, formulae, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability, simple problems, Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA to develop entrepreneurship and skills development.

Unit III **(10 Sessions)**

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions, Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Maintenance Systems: Fixed time maintenance, Condition based maintenance, Operate to failure, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of tero technology for employability and entrepreneurship skills.

Unit IV **(08 Sessions)**

Condition Monitoring: Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic system, Machine diagnostics - Objectives, Monitoring strategies, Examples of monitoring and diagnosis, Control structure for machine diagnosis enhancing employability and skills development.

Unit V **(08 Sessions)**

Safety Aspects: Importance of safety, Factors affecting safety, Safety aspects of site and plant, Hazards of commercial chemical reaction and operation, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety for skills development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of reliability engineering for employability and skill development.
CO2: Understand the basic techniques of quality improvement, fundamental knowledge of statistics and probability to develop entrepreneurship and skills development gaining national and international interest.
CO3: Facilitate employability and entrepreneurship skills by understanding the use control charts to analyze processes.
CO4: Analyze the mechanism and concept of sampling plans enhancing employability and skills development.
CO5: Understand importance, dimension of safety aspects for skills development and employability and develops local and global interest.

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CO 1	2	2	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	3	2	3	3	3	1	1	3
CO 4	2	2	1	2	2	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Concepts in Reliability Engineering L. S. Srinath Affiliated East West Press
2. Maintainability and Reliability Handbook Editors: Ireson W.A. and C.F. Coombs McGraw Hill Inc.
3. Failure Diagnosis and Performance Monitoring L.F. Pau Marcel Dekker
4. Industrial Maintenance Management S. K. Srivastava S. Chand & Co Ltd.
5. Management of Industrial Maintenance Kelly and M.J. Harris Butterworth and Co.
6. Maintenance, Replacement and Reliability A. K. S. Jardine Pitman Publishing
7. Engineering Maintainability: How to Design for Reliability and Easy Maintenance B. S. Dhillon Prentice Hall of India

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
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TMME222: THEORY OF PLASTICITY

Objective: The objective of this course is to familiarize the students to understand the concepts of stresses, strains and stress-strain relationships, as well as Yield and failure criteria. To provide the knowledge of various theoretical elements of plasticity and establish plasticity models for metallic structures. To apply the principles of the theory of plasticity for large deformations in nonlinear analysis ofstructuresfor entrepreneurship and skill development and employability.

Unit I **(05 Sessions)**

Theory of Plasticity: Nature of engineering plasticity, Differential equations of equilibrium for employability and skill development.

Unit II **(09 Sessions)**

3D stress analysis, infinitesimal deformation, finite deformation, Von Mises', Tresca's and anisotropic yield criteria, halgh-Westergard stress space representation of yield criteria, experimental verification of yield criteria, Subsequent yield surfaces to develop entrepreneurship and skills development.

Unit III **(08 Sessions)**

Elastic and plastic stress-strain relations and stress strain rate equations, Prandtle-Reuaa equations, generalized plastic stress strain relations, Anisotropy and instability employability and entrepreneurship skills.

Unit IV **(09 Sessions)**

Plane plastic flow, Slip-line field theory, Application of slip line field theory to plane strain metal forming processes, Plane plastic stress and pseudo plane stress analysis and its applications enhancing employability and skills development.

Unit V **(09 Sessions)**

Extremum principle for rigid perfectly plastic material, surfaces of stress and velocity discontinuity, Upper bound and lower bound theorems and applications for skills development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of theory of plasticity for employability and skill development.
CO2: Understand the elastic and plastic behavior from stress-strain curves for materials to develop entrepreneurship and skills development gaining national and international interest.
CO3: Facilitate employability and entrepreneurship skills by recognizing typical plastic yield criteria established in constitutive modeling.
CO4: Develops local and global interest by understanding the physical interpretation of material constants in mathematical formulation of constitutive relationship enhancing employability and skills development.
CO5: Solve analytically the simple boundary value problems with elasto-plastic properties and develop constitutive models based on experimental results on material behavior for skills development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Applied Plasticity Chakrabarty J Springer-Verlog
2. The Mathematical Theory of Plasticity R Hill Oxford University

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME223: RAPID PROTOTYPING AND TOOLING

Objective: The prime objective of this subject is to explore the automatic fabrication of 3D physical parts using additive manufacturing technology. To use of additive manufacturing for rapid prototyping takes designs from computer aided design (CAD), tessellates them in RP software and then build the actual physical 3D models in an additive manner layer-by-layer. Students are also able to explore various design aspects of machine tools elements like transmissions, structures, materials, kinematics, dynamics and construction of machine tools, etc. to understand concepts related to design of Die and punch for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

Definition & Concept of Rapid Prototyping processes, Need of RP in context of batch production, Basic Principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP. Classifications of different RP techniques based on raw material, layering technique (2D or 3D) and energy sources for employability and skill development.

Unit II **(08 Sessions)**

Process Technology, Basic concept & process detail of RP process like Stereo- lithography (SL), Solid foil polymerization, Selective laser sintering, Selective powder binding, Ballastic particle manufacturing both 2D and 3D, Fused Deposition Modelling, Shape Melting for entrepreneurship and skills development.

Unit III **(06 Sessions)**

Laminated Object Manufacturing, Solid Ground Curing, Repetitive Masking and deposition, Beam Inference, Solidification, Holographic Interference Solidification for employability and entrepreneurship skills.

Unit IV **(10 Sessions)**

Special Topic on RP using metallic alloys Solid ground curing laminated object manufacturing, fused deposition modeling, three dimensional printing, ballistic particle manufacturing & vacuum casting, advantages applications & limitation. Programming in RP, Modelling, Slicing, Internal Hatching, Surface Skin Fills, Support Structure. Technology for Rapid Prototyping, Selection materials enhancing employability and skill development.

Unit V **(08 Sessions)**

Development of 3D model & transforming it to the RP machine.Supporting techniques & development of the workpiece. Post processing part removal, part cleaning, post curing, part finishing, machine accuracy & part accuracy. Some case studies & application of Auto industries, die industries, medical appliances, etc. for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, need, application and scope of Rapid Prototyping processes for employability and skill development.
CO2: Gaining national and international interest by understanding the Process Technology and Rapid Prototyping Technology over the existing traditional methods in present competitive scenario in terms of product development cycle for entrepreneurship and skill development.
CO3: Facilitate employability and entrepreneurship skills by recognizing advanced concept of Laminated Object Manufacturing.
CO4: Understand the insight into various modern rapid prototyping techniques, how the different processes work, how they have developed, as well as weaknesses of each technology enhancing employability and skill development.
CO5: Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools for skill development and employability and develops local and global interest.

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CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

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	Skill Development	Employability	Entrepreneurship Development
CO 1	3	3	1
CO 2	3	2	3
CO 3	1	3	3
CO 4	3	3	1
CO 5	3	3	1

Suggested Readings:

1. Paul F. Jacobs, Rapid prototyping & Manufacturing Fundamental of sterolithiography, SME Publications
2. Amitabh Ghosh, Rapid Prototyping, East West Press Pvt. Ltd
3. Chua C. K., Leong K. F. and Lim C. S., Rapid Prototyping, Principles and Application, World scientific publishing Co. Pvt. Ltd., Singapore
4. Andreas gebhardt, Rapid prototyping, Hansergardner publications, USA
5. Kenneth g. cooper, Rapid prototyping technology

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
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TMME301: PRODUCTION TECHNOLOGY

Objective: To impart knowledge to students in the latest technological topics on Production and Industrial Engineering and to provide them with opportunities in taking up advanced topics of the field of study to provide employability, skills and entrepreneurship development.

UNIT I **(08 Sessions)**

Welding Technology: Welding comparison with other fabrication processes, Classification, Fusion and pressure welding, Weldability of metals, Metallurgy of welding, Weld design, Stress distribution and temperature fields in the welds, Recent developments in welding viz. Diffusion, Friction, Electron beam and Induction welding for skill development & entrepreneurship.

UNIT II **(08 Sessions)**

Cladding, Metalizing, Surfacing and Fabrication, Welding defects and inspection of welds, Thermal cutting of metals and its use in fabrication of process machines, cutting of cast iron, stainless steel and non-ferrous metals for skill development & entrepreneurship.

UNIT III **(12 Sessions)**

Metal Forming: Classification of forming process, Stress, strain and strain rules, laws, Yield criterion and flow rules, Friction and lubrication in metal forming processes, Indirect compression processes e.g., Drawing and Extrusion processes, Direct compression processes e.g., forming and rolling, Theory of deep drawing, Load bounding techniques and upper bound estimates of field theory, Bending and forming, High-energy rate forming techniques and their applications, Recent advances in metal forming for skill development.

UNIT IV **(04 Sessions)**

Metal Cutting: Tool geometry and signature, Theory of orthogonal and oblique metal cutting, Tool wear and lubrication for skill development

UNIT V **(08 Sessions)**

Theoretical evaluation of temperature fields at shear zone and tool-chip interface, Dynamics of metal cutting and machine tool stability, A critical review of theories of dynamic cutting machining at super high speeds, recent advances in cutting tool and science of metal cutting for skill development & entrepreneurship.

Course Outcomes: Students completing this course will be able to:

CO1: Ability to understand Welding and its types, classification, metallurgy and design of weld, also the recent welding techniques for skill development & entrepreneurship.
CO2: Able to understand process like Cladding, Metallizing, fabrication and cutting of important engineering materials, including clear concept of weld quality for skill development & entrepreneurship gaining national and international interest.
CO3: Capable to understand forming process followed by direct & indirect compression process for skill development.
CO4: Understand the importance of tool geometry & signature, tool wear & lubrication during metal cutting operations for skill development.
CO5: Able to understand the method of chip formation and importance of shear zone temperature at the tool chip interface. Also familiar with the recent advancements in the field of metal cutting science for skill development & entrepreneurship.

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CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	2	3	1	2	3	3	2	3	1	2
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	3
CO2	3	1	3
CO3	3	2	1
CO4	3	2	1
CO5	3	1	3

Suggested Readings:

1. Fundamentals of Metal Machining G. Boothroyd
2. Metal Forming Analysis Avitzur
3. Metal Cutting Principle M.C. Shaw
4. Theory of Plastic Deformation and Metal Working V. Masterov& V. Berkovsky
5. Metal Cutting E.M. Trent

Website Sources:

- https://www.plattecountyschooldistrict.com/domain/1481
- https://courses.lumenlearning.com/atd-baycollege-introbusiness/chapter/reading-the-technology-of-goods-production/
- https://www.springer.com/gp/book/9783319485775

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TMME302: Non Destructive Testing

Objective: The main objectives of this course is to introduce the concept of non-destructive testing among the students and make them understand various types of non-traditional practices available for manufacturing industry to provide employability, skills and entrepreneurship development.

UNIT I **(08 Sessions)**

Introduction: Scope and advantages of NDT. Comparison of NDT with DT.Some common NDT methods used since ages.Terminology.Flaws and defects, visual inspection, equipments used for visual inspection. Ringing test, chalk test (oil whitening test). Attractive uses of above tests in detecting surface cracks, bond strength & surface defects for entrepreneurship.

UNIT II **(08 Sessions)**

Die penetrate test:(liquid penetrate inspection), principle, scope. Equipment and techniques, tests stations, advantages, types of penetrant and developers. Illustrative examples – heavy castings of large size, frame of jet engine, porosity testing of nickel alloys, leak testing.Zyglotest.**Magnetic particle Inspection** – Scope, principle, ferro magnetic and non-ferromagnetic materials, equipment and testing. Advantages, limitations, interpretation of results. DC and AC magnetization, skin effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, applications for skill development and entrepreneurship.

UNIT III **(08 Sessions)**

Radiographic methods: X-ray radiography principle, equipment & methodology. Applicability, types of radiations, limitations. Interpretation of radiographs, limitations of γ-ray radiography – working principle and equipments.Attenuation of electromagnetic radiations, source of radioactive materials and technique. Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering). Pair production, beam geometry, scattering factor.Advantages of γ-ray radiography over X-ray radiography.Precautions against radiation hazards.Case Study – X-ray of human body for skill development and entrepreneurship.

UNIT IV **(08 Sessions)**

Ultrasonic testing methods: Introduction, principle of operation, piezoelectricity. Ultrasonic probes, CRO techniques, advantages, limitation & typical applications. Applications in inspection of castings, forgings, extruded steel parts, bars, pipes, rails and dimensions measurements. Case study – Ultrasonography of human body for skill development and entrepreneurship.

UNIT V **(08 Sessions)**

Eddy Current Inspection: Principle, methods, advantages, scope and limitations. Types of Probes. Case Studies for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Define the NDT. It also deals with introduction of materials for entrepreneurship gaining national and international interest.
CO2: Provide the information about common non-destructive testing methods like die penetrant test and magnetic particle inspection for skill development and entrepreneurship.
CO3: Describe and discuss the use of X-Ray radiography, their classification, their uses and its application in industry for skill development and employability.
CO4: Provide the information about ultra-sonic testing of different components in the industry. It also develops the ability to use ultra-sonic testing methods for different purposes for skill development and entrepreneurship.
CO5: Provide information relating to eddy current inspection, use of eddy current inspection for different purpose. It also develops the ability of student to use eddy current inspection methods in different way for skill development and employability.

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CO 4	2	3	3	2	3	3	3	3	1	2
CO 5	3	3	3	2	3	3	3	2	3	3

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	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	3
CO2	3	2	3
CO3	3	3	1
CO4	3	1	3
CO5	3	3	1

Suggested Readings:

1. Malhotra, "Handbook on Non-destructive Testing of Concrete", Publisher: CRC Press, 2002.
2. Mix, Paul E, "Introduction to Nondestructive Testing: A Training Guide", John Wiley and Sons Ltd, 1999.
3. Blitz and Jack, "Electrical and Magnetic Methods of Nondestructive Testing", Institute of Physics Publishing, 2001.
4. Achenbach, J D, "Evaluation of Materials and Structures by Quantitative Ultrasonics", Springer-Verlag Vienna, 2001.
5. Henrique L M, "Non Destructive Testing and Evaluation for Manufacturing and Construction", Hemisphere Publishers, New York, 2001.

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- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
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(Effective from Session 2021-22)

TMME311: NEURAL NETWORK AND FUZZY SYSTEMS

Objective: The objective of this course is to familiarize the students to gain insight about the basics of Neural Networks and essentials of Artificial Neural Networks with Single Layer and Multilayer Feed Forward Networks. . It deals with Associate Memories and introduces Fuzzy sets and Fuzzy Logic system components, to provide the student with the basic understanding of neural networks and fuzzy logic fundamentals for entrepreneurship and skill development and employability.

Unit I **(6 Sessions)**
Introduction to neural network and fuzzy systems; artificial neural networks and their biological roots; ANN as numerical data/signal processing device for skill development and employability.

Unit II **(8 Sessions)**
Taxonomy of neural networks, Feed forward and recurrent neural networks; Supervised and unsupervised learning; Various training methods; Importance of back propagation methods; Adoptive resonance theory for employability and entrepreneurship skills.

Unit III **(8 Sessions)**
Fundamentals of fuzzy logic systems; Operations on fuzzy sets, Complements, intersections and unions etc., Fuzzy arithmetic, Crisp vs fuzzy relations; Fuzzy equivalence; Compatibility and ordering relations for skill development and employability.

Unit IV **(10 Sessions)**
Fuzzy morphisms; Fuzzy relation equations and approximate solutions; Fuzzy logic and multi valued logic; Fuzzy propositions; Fuzzy quantifiers; Linguistic hedges; Fuzzy system controllers- an operative and examples to develop entrepreneurship skills.

Unit V **(08 Sessions)**
Fuzzy dynamic systems such as pattern recognition systems, Fuzzy databases and information retrieval systems, neuro-fuzzy systems; Computational intelligence paradigm and its applications for employability and skill development.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept of neural network and fuzzy systems; Artificial neural networks and their biological roots; ANN as numerical data/signal processing device for skill development and employability.
CO2: To apply various training methods; Importance of back propagation methods; Adoptive resonance theoryfor employability and entrepreneurship skills gaining national and international interest.
CO3: Understand the fundamentals of fuzzy logic systems; Operations on fuzzy sets, Complements, intersections and unions etc., Fuzzy arithmetic, Crisp vs fuzzy relations; Fuzzy equivalence; Compatibility and ordering relations for skill development and employability.
CO4: Apply theoretical and experimental equations and approximate solutions; Fuzzy logic and multi valued logic; Fuzzy propositions; Fuzzy quantifiers; Linguistic hedges; Fuzzy system controllers- an operative and examples to develop entrepreneurship skills and develop local and global interest.
CO5: Analyze and apply the concept of Fuzzy dynamic systems such as pattern recognition systems and its applications for employability and skill development

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	2	2	3	2	3	3
CO 3	1	1	3	3	2	2	3	2	2	3
CO 4	3	2	2	3	3	2	2	1	3	2
CO 5	3	3	2	3	3	2	3	2	2	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	2	3	3
CO3	3	3	1
CO4	1	2	3
CO5	3	3	1

Suggested Readings:

1. Neural Network Learning: Theoretical Foundations Anthony Martin M Cambridge University
2. Neural Network Perception for Mobile Robot Guidance Ean A Pomerleau –
3. Neural Networks and Fuzzy Systems Shigeo Abe –
4. Fuzzy Systems Engineering: Theory and Practice Nadia Nedjah Springer Verlog

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

Note: Latest editions of all the suggested readings must be used.

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TMME312: MICRO-ELECTRO MECHANICAL SYSTEMS

Objective: The objective of this course is to familiarize the students to gain insight about the Micro-electromechanical systems (MEMS) is a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using integrated circuit (IC) batch processing techniques and can range in size from a few micrometers to millimeters. These devices (or systems) have the ability to sense, control and actuate on the micro scale, and generate effects on the macro scale for entrepreneurship and skill development and employability.

Unit I **(06 Sessions)**
It's Elements – such as mechanics, electronics, microelectronics, power electronics and information technologies for employability and skill development.

Unit II **(08 Sessions)**
Mechanical elements with integrated electronics, Suspension systems, Vibration dampers, Clutches, Bearings- Mechanical/magnetic, gears etc. for skill development and employability.

Unit III **(08 Sessions)**
Micro-motors, DC motors, PCB motors, Disc motors, Reluctance motors, PM motors, Brushless motors for skill development and employability.

Unit IV **(10 Sessions)**
Stepper motors, Universal motors, Aerial field motors, Induction motors, and synchronous motors, Applications to Tele-communication technology equipment to develop entrepreneurship skills.

Unit V **(08 Sessions)**
Computer printers, Actuators, Consumer products such as cameras, Camcorder, Timers, Clock, VCR, wipers, Fax machines, and Recorders for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the principle Elements – such as mechanics, electronics, microelectronics, power electronics and information technologies for employability and skill development.
CO2: Analyze and apply the concept of Mechanical elements with integrated electronics, Suspension systems, Vibration dampers, Clutches, Bearings- Mechanical/magnetic, gears etc. for skill development and employability gaining national and international interest.
CO3: Understand and apply the principles of Micro-motors, DC motors, PCB motors, Disc motors, Reluctance motors, PM motors, Brushless motors for skill development and employability.
CO4: Analyze the mechanism and tools Stepper motors, Universal motors, Aerial field motors, Induction motors, and synchronous motors, Applications to Tele-communication technology equipment to develop entrepreneurship skills and develops local and global interest.
CO5: To control and develop Computer printers, Actuators, Consumer products such as cameras, Camcorder, Timers, Clock, VCR, wipers, Fax machines, and Recorders for employability and entrepreneurship skills.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	2	2	3	2	3	3
CO 3	1	1	3	2	3	1	1	3	2	3
CO 4	3	3	3	3	2	2	3	2	3	3
CO 5	3	3	2	2	3	1	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	3	3	2
CO3	3	3	1
CO4	2	1	3
CO5	2	3	3

Suggested Readings:

1. Mechatronics Bolten
2. Stepper Motors Fundamentals, Applications and Design V. Athani New Edge International
3. Switched Reluctance Motors and Their Control T.J.E. Miller Oxford
4. Permanent Magnet Motor Technology J.F. Gieras and M. Wing M. Dieker
5. Brushless Servo motor Fundamentals and applications Y. Dote & S. Kinoshikha Clarendon Press Oxford

Website sources:

- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

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TMME313: ADVANCE INSTRUMENTATION

Objective: The objective of this course is to familiarize the students to gain insight about the Instrumentation core course is to understand the physical principles of electronic based measurements. There is a strong emphasis on electronics, from fundamentals of analogue and digital circuits to complex components and systems constructed from them for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Transducers: Electro mechanical transducers, Resistance, Inductance, capacitive and Piezoelectric transducers, Thermoelectric and Photoelectric transducers for skill development and employability.

Unit II **(06 Sessions)**
Analog and digital transducers including semiconductor and optical type, Application to measurement of temperature, Pressure for employability and entrepreneurship skills.

Unit III **(08 Sessions)**
Flow displacement and other non-electrical quantities for skill development and employability.

Unit IV **(08 Sessions)**
Introduction to data acquisition system, A/D and D/A converters, Sample and hold circuit, MUX and DEMUX, Signal transmission for employability and skill development.

Unit V **(10 Sessions)**
Introduction to AM, FM, FSK, PSK and PWM modulation and demodulation, Signal to noise ratio and band width considerations for employability and skill development.

Course Outcomes: Students completing this course will be able to:

CO1: Achieving national and international interest by understanding the concept of Electro mechanical transducers, Resistance, Inductance, capacitive and piezoelectric transducers for skill development and employability.
CO2: Analyze and apply the concept of Analog and digital transducers including semiconductor and optical type, Application to measurement of temperature, Pressure for employability and entrepreneurship skills.
CO3: Understand the Flow displacement and other non-electrical quantities for skill development and employability.
CO4: Understand the model of data acquisition system, A/D and D/A converters, Sample and hold circuit, MUX and DEMUX, Signal transmission for employability and skill development and develops local and global interest.
CO5: To control and develop AM, FM, FSK, PSK and PWM modulation and demodulation, Signal to noise ratio and band width considerations for employability and skill development.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	2	3	3
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1

Suggested Readings:

1. Intelligent Instrumentation Barney Prentice hall India
2. Modern electronic Instrumentation & Control Helfrick& Cooper Prentice hall
3. Telemetry System Border &Mayewize
4. Data Communication Schewher McGraw Hill
5. Telemetry Principles Patranabis TMS

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME314: INDUSTRIAL TRIBOLOGY

Objective: The objective of this course is to familiarize the students to gain insight about Tribology is the study of friction, wear and lubrication, and design of bearings, science of interacting surfaces in relative motion. It encompasses a number of basic engineering subjects such as solid mechanics, fluid mechanics, lubricant chemistry, material science and heat transfer for entrepreneurship and skill development and employability.

UNIT I **(06 Sessions)**
Introduction: Definition and Scope of tribology, Contact of solids, Surface topology, Surface interaction for employability and skill development.

UNIT II **(08 Sessions)**
Friction: Definitions, Types, Friction laws, Modern theory of dry solid friction, Temperature of sliding surface, Mechanism of rolling friction, Friction instability, Friction of elastomers for skill development and employability.

UNIT III **(10 Sessions)**
Wear: Definition, Classification, Theories of adhesives, Abrasives, Surface fatigue and corrosive wear, Miscellaneous wear theory such as Erosive, cavitation and Fretting wear, Wear of miscellaneous machine components such as gears, Plane bearings and rolling elements for employability and entrepreneurship skills.

UNIT IV **(08 Sessions)**
Lubrication: Lubrication of bearing, Lubricant, Mineral Oil, Grease, Solid lubricant, Lubrication regime, Viscous flow, Reynolds equation and its limitations, Hydrodynamic lubrication, Hydrostatic lubrication, Elasto-hydrodynamic lubrication, Boundary lubrication, Squeeze films for employability and entrepreneurship skills.

UNIT V **(08 Sessions)**
Applications: Application of tribology in manufacturing processes, Metal machining, Metal cutting, Tool wear, Action of lubricants, Friction welding, Extrusion process to develop entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, development, application and scope of Industrial Tribology for employability and skill development.
CO2: Analyze the mechanism of friction for employability and entrepreneurship skills achieving national and international interest.
CO3: Understand and apply the principles wear for employability and entrepreneurship skills.
CO4: To apply various type of lubricants and lubrication process in systems of different regimes for employability and entrepreneurship skills.
CO5: Understand the application of Tribology in manufacturing processes to develop entrepreneurship skills and develops local and global interest.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	2	3	3
CO3	1	3	3
CO4	1	3	3
CO5	1	2	3

Suggested Readings:

1. Engineering Tribology P Sahoo Prentice Hall of India
2. Principles and Applications of Tribology D.F. Moore Pergamon Press
3. Fundamentals of Tribology Basu, Sengupta& Ahuja Prentice Hall of India
4. Tribology Handbook M. J. Neele

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME315: ADVANCE FLUID MECHANICS

Objective: The objective of this course is to familiarize the students to gain insight about a continuation of Fundamentals of Fluid Mechanics course. It includes: Two-Dimensional irrotational Flow, Three-Dimensional irrotational Flow, C Vortex Motion, Viscous Flow and Compressible Fluid Flow are introduced for entrepreneurship and skill development and employability.

UNIT I **(10 Sessions)**

Two-Dimensional Irrotational Flow: Two dimensional irrotational flow in rectangular and polar coordinates-Continuity equation and the stream function; Irrotationality and the velocity potential function; Voriticity and circulation; Plane potential flow and the complex potential function. Sources, sinks, doublets and vorities-Superposition of uniform stream with above; Flow around corners; Ranbkine ovals; Flow around circular cylinders with and without circulation; Pressure distribution on the surface of these bodies and D'Alembert's paradox; Blasuis theorem for forces and moments; Method of residues, Conformal transformation of flows with solid boundaries. Elements of two-dimensional aerofoil theory; Joukowski transformation; Circular are symmetrical aerofoil theory; Joukowski hypothesis, Lift and moment for skill development and employability.

UNIT II **(06 Sessions)**

Three-Dimensional Irotational Flow: Irrotationality and the velocity potential function; Symmetric flows and the Stokes stream function; Sources, sinks for employability and skill development.

UNIT III **(08 Sessions)**

Vortex Motion: Definition; Vortex lines; Surfaces and tubes; Vorticity; Kelvin's circulation theorem; Helmholtz's vorticity theorems; Convection and diffusion of vorticity. Vortex filament, Biot-Savart law for induced velocities; Rectilinear vortex filaments; System of vortex filaments; Horseshoe vortex filaments; Ring vortices; Vortex sheets; Karman vortex sheet for skill development and employability.

UNIT IV **(10 Sessions)**

Viscous Flow: exact solution; Plane Poiselle and Courtte flows; Hagen-Piselle flow through pipes. Flow with very small Reynold's number, Stoke's flow around a sphere; Seen's approximations; Elements of hydrodynamic theories of lubrication, Hele-Shaw flow. Flows with very large Reynold's number; Elements of two-dimensional boundary solutions for boundary layer on a flat plate without pressure gradient; Karman Polhausen integral method for obtaining approximate solutions. Drag on bodies; Form drag and skin friction drag profile drag and its measurement for employability and skill development.

UNIT V **(06 Sessions)**

Compressible Fluid Flow: Derivation of basic equations, Fanno flow, Rayleigh flow for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Analyze the forces in fluid flow, similitude & dimensional analysis and uniform flow in open channels for skill development and employability.
CO2: Understand the Three-Dimensional Irotational Flow for employability and skill development achieving national and international interest.
CO3: Apply theoretical and experimental techniques for vortex motion for skill development and employability.
CO4: Apply theoretical and experimental techniques for viscous flow for employability and skill development.
CO5:Develops local and global interest by applying the fundamentals of Compressible Fluid Flow for skill development and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	2	2	2	3	2	2	3
CO 4	3	3	2	2	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	3	3	2
CO3	3	3	1
CO4	3	3	2
CO5	3	3	1

Suggested Readings:

1. Fluid Mechanics and Its Applications Vijay Gupta & S.K. Gupta New Age International
2. Fluid Mechanics and Machinery D R Durgaiah New Age International
3. Engineering Fluid Mechanics J A Roberson And C T Crowe Jaico Publishing House
4. Fluid Mechanics: Problems And Solutions Joseph H Spurk
5. Introduction to Fluid Mechanics A.F. James Prentice Hall of India

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

Note: Latest editions of all the suggested readings must be used.

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TMME316: TOTAL QUALITY MANAGEMENT

Objective: The objective of this course is to learn how to plan and execute quality management strategies to gain and maintain a competitive advantage in today's global business era for any organization to provide employability, skills and entrepreneurship development.

UNIT I **(10 Sessions)**

Introduction and Components of TQM: Concept and Philosophy of TQM, Value and Quality assurance, Total Quality Control, Quality policy, Team-work and participation, Quality cost measurement, Quality Circle, Customer/Supplier integration, Education and training for skill development and employability.

UNIT II **(08 Sessions)**

Tools and Techniques of TQM: Statistical method in quality control, Process control chart, Acceptance sampling plan, Statistical Productivity control (SPC) for skill development, employability and entrepreneurship development.

UNIT III **(06 Sessions)**

Reliability: Failure analysis, System reliability and redundomy for skill development and employability.

UNIT IV **(08 Sessions)**

TQM implementation: Steps in promoting and implementing TQM in manufacturing industries, Industrial Case studies for skill development and employability.

UNIT V **(08 Sessions)**

ISO 9000 Quality Systems: Concepts, designation Standards, Quality system documentation, Quality manual, Quality procedures and work inspection for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand detailed philosophy of TQM and realize the importance of quality for skill development and employability.
CO2: To learn how to use control chart techniques and applying statistical methods for improving processes and use this knowledge for skill development, employabilityand entrepreneurship development achieving national and international interest.
CO3: Analyze the tools of quality improvement and reliability problems for skill development and employability.
CO4: Develops local and global interest by learning how to promote and implement TQM in industries for skill development and employability.
CO5: Demonstrate the importance of ISO Quality systems for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	3	3	3
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1

Suggested Readings:

1. Total Quality Control F. Ammandev Tata McGraw Hill
2. Total Quality Management Besterfield, et. al. Prentice Hall of India
3. Total Quality Management: Text and Cases B. Janakiraman& RK Gopal Prentice Hall of India
4. What is Total Quality Control? K. Ishikawa Prentice hall
5. Total Quality Management: The Route to Improving Performance J.S. Oakland Butterworth Heineman Oxford
6. Out of Crisis W.E Dming Centre of Advance Engineering Study, Cambridge

Website Sources:

- www.questia.com/library/economics-and-business/business/management/total-quality-management
- www.tandfonline.com/toc/ctqm20/current
- www.investopedia.com/terms/t/total-quality-management-tqm.asp
- onlinecourses.nptel.ac.in
- www.cgma.org/resources/tools/essential-tools/quality-management-tools.html
- http://www.netugc.com/total-quality-management-tqm

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TMME317: ENGINEERING DESIGN OPTIMIZATION

Objective: The objective of this course is to familiarize the students to gain insight about Model and formulate optimization problems in standard form and assess the optimality of a solution. Write computer code to determine the optimal solution for unconstrained and constrained nonlinear optimization problems of multiple variables, determine the advantages and disadvantages of applying different optimization techniques for a specific problem, Model and analyze multi-objective and multidisciplinary optimization problems for entrepreneurship and skill development and employability.

UNIT I **(04 Sessions)**

Introduction: Historical Developments, Engineering applications of Optimization

UNIT II **(08 Sessions)**

Classical Optimization Techniques: Introduction, Review of single and multivariable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples for employability and skill development.

UNIT III **(10 Sessions)**

Constrained Optimization Techniques: Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems for employability and entrepreneurship skills.

Unconstrained Optimization Techniques: Introduction, Direct search method - Random, Univariate and Pattern search methods, Rosenbrock's method of rotating co-ordinates, Descent methods - Steepest Decent methods-Quasi-Newton's and Variable metric method, Examples for employability and entrepreneurship skills.

UNIT IV **(09 Sessions)**

Geometric Programming: Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, Constrained minimization problems, Generalized polynomial optimization, Applications of geometric problems, Introduction to stochastic optimization for employability and skill development.

UNIT V **(09 Sessions)**

Novel methods for Optimization: Introduction to simulated annealing, selection of simulated annealing parameters, simulated annealing algorithm; Genetic Algorithm (GA), Design of GA, Key concepts of GA, Neural Networks, A frame work for Neural Network models, Construction of Neural Network algorithm, Examples of simulated algorithm, genetic annealing and Neural Network method for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Achieving national and international interest by understanding the concept, development, application and scope of Optimization for employability and skill development.
CO2: Understand the concept of Classical Optimization Techniques with minimization problems, Examples for employability and skill development.
CO3: To apply various Constrained Optimization and Unconstrained Optimization Techniques for employability and entrepreneurship skills.
CO4: Apply the fundamentals of Geometric Programming **for employability and skill development and develops local and global interest.**
CO5: Analyze and apply the concept of Novel methods for Optimization with Examples of simulated algorithm, genetic annealing and Neural Network method for skill development and employability.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	3	3	3
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1

Suggested Readings:

1. Engineering Optimization S. S. Rao New Age International
2. Applied Optimal Design E. J. Haug and J. S. Arora Wiley, New York
3. Optimization for Engineering Design Kalyanmoy Deb Prentice Hall of India
4. Optimization G. V. Reklaites, A. Ravindran and K.M. Rogsdeth Wiley, New York

Website sources:

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- www.researchgate.net
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com

Note: Latest editions of all the suggested readings must be used.

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Department of Mechanical Engineering

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(Effective from Session 2021-22)

TMME318: RESEARCH METHODOLOGY

Objective: To develop an understanding between Introductions of research, types of research, research process, research design research approaches, criteria of good research. Plagiarism – definition, forms of plagiarism, consequences of plagiarism, unintentional plagiarism, copyright infringement, collaborative work. Data collection, sampling & sampling design-probability sampling, non-probability sampling. Statistical tools and techniques: Measures of dispersion, correlation, regression, hypothesis testing parametric tests, construction of control charts. Simulation and numerical methods, Experimental designs and analysis, Development of theory and linkages and interpretation of results, Concepts of Artificial intelligence and associated techniques. Identifying and Defining Research problems, Setting feasible goals & objectives, Improving reading, writing and speaking skills, Communication Skills, Principles of research paper, report and thesis writing for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Introduction of research, types of research, research process, research design research approaches, criteria of good research.
Plagiarism – definition, forms of plagiarism, consequences of plagiarism, unintentional plagiarism, copyright infringement, collaborative work for skill development and employability.

Unit II **(08 Sessions)**
Data collection, sampling & sampling design probability sampling, non probability sampling. Statistical tools and techniques: Measures of dispersion, correlation, regression, hypothesis testing parametric tests, construction of control charts to develop entrepreneurship skills.

Unit III **(08 Sessions)**
Simulation and numerical methods, experimental designs and analysis, development of theory and linkages and interpretation of results, Concepts of Artificial intelligence and associated techniques for employability and entrepreneurship skills.

Unit IV **(08 Sessions)**
Identifying and Defining Research problems, Setting feasible goals & objectives, Improving reading, writing and speaking skills. Communication Skills, Principles of research paper, report and thesis writing for skill development and employability.

Unit V **(08 Sessions)**
Guidelines according to style manuals, report format- writing and presentation of preliminary, main body and references section of report, Bibliography and Annexure in the Report, development of research proposals and patents for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept of research, types of research, research process, research design research approaches, criteria of good research, forms of plagiarism, copyright infringement, collaborative work for skill development and employability achieving national and international interest.
CO2: To control and develop Data collection, sampling, Statistical tools and techniques: Measures of dispersion, correlation, regression, hypothesis testing parametric tests, construction of control charts to develop entrepreneurship skills.
CO3: Apply theoretical and experimental techniques for Simulation and numerical methods, experimental designs and analysis, development of theory and linkages and interpretation of results, Concepts of Artificial intelligence and associated techniques for employability and entrepreneurship skills.
CO4: Analyze and apply the concept of Research problems, Setting feasible goals & objectives, writing and speaking skills. Communication Skills, Principles of research paper, report and thesis writing for skill development and employability and develops local and global interest.
CO5: To control and develop models for style manuals, report format- writing and presentation of preliminary, Bibliography and Annexure in the Report, development of research proposals and patents for employability and entrepreneurship skills.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	1	3	2	3	2	2	3	1	2
CO 2	3	2	2	3	3	2	3	2	3	3
CO 3	2	1	2	3	3	2	1	2	2	2
CO 4	2	3	3	2	3	3	3	3	1	2
CO 5	3	3	3	2	3	3	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	2	3	3
CO3	1	3	3
CO4	3	3	2
CO5	2	3	3

Suggested Readings:

1. PanneerSelvam, Research Methodology, Prentice Hall of India, Edition 2008
2. Kothari V.R., Research Methodology Methods & Techniques, New Age International Publishers, 2nd Edition, 2006
3. Gupta and Singh, Research Methodology, Vayu Education of India, New Delhi
4. Bhattacharya, D.K., Research Methodology, New Delhi, Excel Books
5. R. Pannerselvam, Research Methodology, Prentice Hall of India Pvt. Ltd., New Delhi, 2004
6. Cooper and Schindler, Business Research Methods, Tata McGraw Hill, 9th Edition
7. Srivastava and Shailaja, Business Research Methodology, Tata McGral Hill, New Delhi
8. R. S. Dwivedi, Research Methodology in Behavioural Science, McMillan India Ltd. New Delhi, 2005

Website sources:

- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME319: NANOTECHNOLOGY AND ITS APPLICATIONS

Objective: Subject structure mainly concerned with detailed introduction of nanomaterials. Why nanomaterials different with macro scale and microscale materials adequately discussed in this subject. Different manufacturing and synthesis techniques for nanoscale material and devices are major focus of the subject structure design. Various characterization techniques along with application in nano-micro equipment design is aim of this subject for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

The nanoscale dimension and paradigm, Definitions, history and current practice, structure, size dependence of properties, crystal structures, face centered cubic Nano particles, Lattice vibrations, methods of measuring properties atomic structures, crystallography, particle size, determination, surface structures for skill development and employability.

Unit II **(08 Sessions)**

Transmission electron microscopy, field ion microscopy, scanning microscopy, infrared and Raman spectroscopy, photoemission and x- ray spectroscopy, magnetic resonance, Overview of current industry applications, Nanoscale science and engineering principles, engineering principles for nanotechnology materials and applications to develop entrepreneurship skills.

Unit III **(08 Sessions)**

Carbon Nanotube Technologies (CNT), From graphite to bucky balls to CNT, Carbon nanotube applications and multi-walled carbon nano-tubes (MWCNT), Fabricating carbon nanotubes and nano-wall structures, Key applications of CNT and MWCNT, Nanolithography, Thin film processes, Imaging using scanning electron micro-scope (SEM), SPM-AFM for employability and entrepreneurship skills.

Unit IV **(08 Sessions)**

Traditional surface and materials analysis techniques, Molecular manufacturing, Self-assembly and 'bottom-up' manufacturing, Thin film applications, Thin film deposition processes, Applications in thin film deposition for skill development and employability.

Unit V **(08 Sessions)**

Quantum well, wires and dots- Introduction, preparation of quantum nanostructures, size and dimensionality effects, potential wells, nanomachines and nanodevices, microelectronic mechanical systems (MEMS), Nanoelectro mechanical systems (NEMS)for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the concept, structure, properties and determination of Nanotechnologyfor employability and skill development.
CO2: To apply various microscopy Overview of current industry applications, Nanoscale science and engineering principles, engineering principles for nanotechnology materials and applications to develop entrepreneurship skills achieving national and international interest.
CO3: Facilitate employability and entrepreneurship skills by understanding the importance of CNT and MWCNT, Nanolithography, Thin film processes, imaging using scanning electron micro-scope (SEM), SPM-AFM
CO4: Develops local and global interest by analyzing the Traditional surface and materials analysis techniques, Molecular manufacturing, Self-assembly and 'bottom-up' manufacturing, Applications in thin film deposition for skill development and employability.
CO5: To control and develop models for nano machines and nano devices, microelectronic mechanical systems (MEMS), Nanoelectromechanical systems (NEMS)for skill development and employability.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	1	3	2	3	2	2	3	1	2
CO 2	3	2	2	3	3	2	3	2	3	3
CO 3	2	1	2	3	3	2	1	2	2	2
CO 4	2	3	3	2	3	3	3	3	1	2
CO 5	3	3	3	2	3	3	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	1	2	3
CO3	2	3	3
CO4	3	3	1
CO5	3	3	1

Suggested Readings:

1. Charles P, Poole Jr. and Owens, Introduction to Nano technology, Wiley Interscience
2. Bharat Bhushan, Springer Handbook of Nanotechnology, Springer
3. Mark A Ratner, Nanotechnology a gentle introduction to the next big idea, Pearson Education and Company
4. H. F. Tibbalas, Introduction to Nano science and nanotechnology, CRC Press

Website sources:

- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net
- www.sanfoundry.com

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TMME320: GAS TURBINES AND JET PROPULSION

Objective: To make clear idea about the Physical difference between incompressible, subsonic and supersonic flows. Analysis of piston excited waves, shock tubes, one-dimensional isentropic flow, normal shocks, Rayleigh flow, and Fanno flow. To understand the basic function of Gas turbine plant, design consideration. Trouble shooting, maintenance and actual performance evaluation of gas turbine plants, Study and design considerations of main components of jet propulsion plants, Recent advances in jet propulsion and Rocket propulsion devices for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

Review of Gas Dynamics: Physical difference between incompressible, subsonic and supersonic flows, three reference speeds, dimensionless velocity, concepts of static and stagnation parameters. Pressure waves, finite, shock and detonation waves, compound waves, Analysis of piston excited waves, shock tubes, one-dimensional isentropic flow, normal shocks, Rayleigh flow, and Fanno flow for skill development and employability.

Unit II **(08 Sessions)**

Gas Turbine Outline: Review of Thermodynamic principles, Gas turbine cycles, main components of Gas turbine power plants, performance characteristics, typical Gas Turbine Plants, Methods of improving efficiency and power output of gas turbine plants.

Design considerations of Centrifugal and axial flow compressors for employability and entrepreneurship skills.

Unit III **(08 Sessions)**

Types of Gas turbine plants and their theory of operation, design consideration of gas turbine plants, Detailed study of main systems of gas turbine plants, Selection of materials of Gas turbine components. Trouble shooting maintenance and actual performance evaluation of gas turbine plants, recent development of gas turbine plants to develop entrepreneurship skills.

Unit IV **(08 Sessions)**

Jet Propulsion Outline: Basic theory of Jet & rocket propulsion devices and historical development. Types of various jet propulsion plants like air screw, turboprop, turbojet, Ram jet, pulse jet, rocket propulsion, etc. and their comparative study for employability and entrepreneurship skills.

Unit V **(08 Sessions)**

Performance study of various jet propulsion devices from ideal and practical consideration, Study and design considerations of main components of jet propulsion plants, Thrust augmentation devices and their thermodynamic analysis, Combustion performance, products of combustion and their properties. Recent advances in jet propulsion and Rocket propulsion devices for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understand and apply the different types of flow like Rayleigh flow and Fanno flow for skill development and employability.

CO2: Analyze and apply the concept the basic function, main components, performance characteristics and Methods of improving efficiency and power output of gas turbine plantsfor employability and entrepreneurship skills.

CO3: Apply the concept thebasicfunction,designconsideration,troubleshootingandperformanceevaluation of gas turbine plants to develop entrepreneurship skills.

CO4: Understand the model of Basic theory of Jet & rocket propulsion devices and types of various jet propulsion plants like air screw, turboprop, turbojet, Ram jet, pulse jet, rocket propulsion, etc. and their comparative study for employability and entrepreneurship skills and develops local and global interest.

CO5: Apply the fundamentals of various jet propulsion devices from ideal and practical consideration, recent advances in jet propulsion and Rocket propulsion devices for skill development and employability.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	1	3	2	3	2	2	3	1	2
CO 2	3	2	2	3	3	2	3	2	3	3
CO 3	2	1	2	3	3	2	1	2	2	2
CO 4	2	3	3	2	3	3	3	3	1	2
CO 5	3	3	3	2	3	3	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	1
CO2	2	3	3
CO3	2	1	3
CO4	2	3	3
CO5	3	3	1

Suggested Readings:

1. "Gas Dynamics", E. Rathakrishnan, Prentice-Hall of India, New Delhi, 2002.
2. "Compressible Fluid Flow", M. A. Saad, Prentice-Hall, New Jersey, 1985.
3. "The Dynamics and Thermodynamics of Compressible Fluid Flow" (2 volumes), A. H. Shapiro, The Ronald Press, New York, 1953.
4. "Gas Turbine Fundamentals", Cohen, Rogers and Saravanamutto, Pearson Education.
5. "Jet Propulsion", Jack D. Mattingly, McGraw Hill Inc.
6. "Gas Turbines", V. Ganeshan, Tata-McGraw-Hill, New Delhi.
7. "Gas Turbines", R. Yadav.

Website sources:

- nptel.ac.in/course.html
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com
- www.slideshare.net
- www.researchgate.net

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TMME321: DESIGN OF EXPERIMENTS

Objective: Design of Experiments, or DOE, is a tool to develop an experimentation strategy that maximizes learning using a minimum of resources. Design of Experiments is widely used in many fields with broad application across all the natural and social sciences. It is extensively used by engineers and scientists involved in the improvement of manufacturing processes to maximize yield and decrease variability. Often times, engineers also work on products or processes where no scientific theory or principles are directly applicable. Experimental design techniques become extremely important in such situations to develop new products and processes in a cost- effective and confident manner for entrepreneurship and skill development and employability.

Unit I **(06 Sessions)**
Introduction to DOE, Review of basic statistical concepts, Introduction to ANOVA, Some practical aspects of planning experiments for skill development.

Unit II **(08 Sessions)**
Multiple comparisons, residuals and model adequacy checking, checking model assumptions, the Box-Cox Method, Choice of sample size in designed experiments for employability and skill development.

Unit III **(08 Sessions)**
Dispersion versus location effects, the randomized complete block design (RCBD). Latin square and related design for employability and entrepreneurship skills.

Unit IV **(08 Sessions)**
Introduction to Factorial Design, 2k Factorial Design, Blocking and Confounding in 2k Factorial Design, 2k-p fractional factorial design, Response Surface Methods (RSM) to process optimization for employability and entrepreneurship skills.

Unit V **(10 Sessions)**
Canonical form of second order response surface model, Taguchi approach to robust design, Taguchi's Technical Methods, Random factors in experiments, nested and split-plot design, non-normal responses and transformations, unbalanced data in a factorial design, analysis of covariance (ANCOVA) repeated measures design for skill development and employability.

Course Outcomes: Students completing this course will be able to:
CO1: Understand the concept of DOE, Review of basic statistical concepts, introduction to ANOVA for skill development**achieving national and international interest.**
CO2: Understand experimentation is a process; list the guidelines for designing experiments for employability and skill development.
CO3: To apply various dispersion versus location effects, the randomized complete block design for employability and entrepreneurship skills.
CO4: Apply the fundamentals of factorial design, blocking, and response surface Methods to process optimization for employability and entrepreneurship skills.
CO5: Analyze and apply the Canonical form of second order response surface model, Taguchi approach to robust design, Taguchi's Technical Methodsfor skill development and employability and develops local and global interest.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	2	2	3	3
CO 3	1	1	3	3	3	2	1	3	2	3
CO 4	3	3	2	3	3	2	3	3	2	3
CO 5	3	3	2	3	3	2	3	3	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	2	1
CO2	3	3	1
CO3	2	3	3
CO4	1	3	3
CO5	3	3	1

Suggested Readings:

1. D.R. Cox, Nancy Reid, The Theory of the Design of Experiments, Chapman & Hall, CRC Press, America.
2. Jiju Antony Design of Experiments for Engineers and Scientists, Butterworth & Heinemann Press, Great Britain.
3. Larry B. Barrentine, An Introduction to Design of Experiments: A Simplified Approach, ASQ Quality Press Publications, USA.
4. Design and Analysis of Experiments: Douglas C. Montgomery, Wiley India Pvt. Ltd.
5. Design of Experiments: Principles and Applications by Lennart Eriksson, MKS Umetrics AB, 2008

Website sources:

- www.slideshare.net
- www.researchgate.net
- www.nsf.gov
- en.wikipedia.org
- www.sciencedirect.com

Note: Latest editions of all the suggested readings must be used.

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TMME322: TECHNOLOGY OF COMPETITIVE MANUFACTURING

Objective: The basic objective of the present course is to acquaint the participants with the conceptual framework and formulation different manufacturing strategies for competitive environment. To understand the concept of value engineering, lean manufacturing, six sigma to improve effectiveness of the product and processes. Participants are able to identify and asses new technologies to design and planning of futuristic factories for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**
Manufacturing Strategy: Conceptual framework and competitive environment, manufacturing problems, Manufacturing Audit and strategy formulation, Diagnostic review and opportunity assessment.Technological strategy for skill development.

Unit II **(06 Sessions)**
Strategic planning, product and process design for improved Manufacturability and producibility, identification and assessment of new technologies for employability and skill development.

Unit III **(08 Sessions)**
Value Engineering: Concept of Value & function, reasons for unnecessary cost, methodology & techniques, acceptance problems, value engineering effectiveness, profit impact of value engineering, industrial and business applications for employability and skill development.

Unit IV **(08 Sessions)**
Lean Manufacturing: concept, goals, components, tools and techniques, JIT, KANBAN system, waste reduction. Six sigma as manufacturing strategy: Concept, methodology and applications for employability and skill development.

Unit V **(10 Sessions)**
Building Manufacturing Competitiveness: SIPOC analysis, focused manufacturing, agile manufacturing, intelligent manufacturing, digital manufacturing, rapid response manufacturing and customer satisfaction.Concept of flexibility and flexible manufacturing systems, Decision and choice regarding FMS configuration. Factories of future: Nature and categories of FOF, Zero base FOF, Design and planning for futuristic factories for employability and entrepreneurship skills.

Course Outcomes: Students completing this course will be able to:

CO1: Understand the manufacturing strategy: conceptual framework and competitive environment for skill development.
CO2: Understand the concept of Strategic planning, product and process design for improved Manufacturability for employability and skill development achieving national and international interest.
CO3: Analyze and apply the concept of value & function, reasons for unnecessary cost, methodology & techniques for employability and skill development.
CO4: Apply the fundamentals of Lean Manufacturing and manufacturing strategy for employability and skill development.
CO5: Develops local and global interest by formulating and reviewing the manufacturing strategies for competitive environment for employability and entrepreneurship skills.

PO-CO Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
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	Skill development	Employability	Entrepreneurship development
CO1	3	2	1
CO2	3	3	2
CO3	3	3	1
CO4	3	3	1
CO5	2	3	3

Suggested Readings:

1. Skimmar, Wickham, Manufacturing in the corporate Strategy, John Wiley and sons, NewYork
2. Hearm Buck and Butler, D.M., Economic product Design, Colhins, London
3. Cluttarbuck, JIT – A Global Status Report, IFS publications
4. Michael J. Termini, The new manufacturing engineer, Society of manufacture engineer Michigan, USA

Website sources:

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- en.wikipedia.org
- www.sciencedirect.com

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TMME323: ENERGY CONSERVATION AND MANAGEMENT

Objective: The main objective of this course is to understand the principles associated with effective energy management and to apply these principles in the day-to-day life. To gain exposure to energy auditing, to identify energy conservation opportunities in various industrial processes and to evaluate the performance of boilers, furnaces and other energy intensive equipment/processes for entrepreneurship and skill development and employability.

Unit I **(08 Sessions)**

INTRODUCTION: Principles of energy management. Managerial organization, Functional areas for i)manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs for employability and skill development

Unit II **(06 Sessions)**

ENERGY AUDIT: Definition and concepts. Types of energy audits, Basic energy concepts, Resources for plant energy studies.Data gathering, Analytical techniques for employability and skill development.

Unit III **(08 Sessions)**

Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options. Process integration for employability and entrepreneurship skills.

Unit IV **(08 Sessions)**

ENERGY EFFICIENCY: Fuels and Combustion-Boilers-Steam System-Furnaces
- Insulation and Refractory -FBC Boilers -Cogeneration -Waste heat recovery, Diesel Generating System for employability and entrepreneurship skills.

Unit V **(10 Sessions)**

ENERGY PERFORMANCE ASSESSMENT: Equipment and Utility systems -Boilers- Furnaces-Cogeneration, Turbines (Gas, Steam)- Heat Exchangers-Electric Motors and Variable Speed, Drives-Fans and Blowers-Water Pumps-Compressors.

ALTERNATIVE ENERGY SOURCES: Solar energy: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems. Waste Minimization and Resource Conservation for skill development and employability.

Course Outcomes: Students completing this course will be able to:

CO1: Understanding of energy conservation and identification of energy conservation management for employability and skill development.
CO2: Knowledge of various tools and components of energy auditingfor employability and skill development achieving national and international interest.
CO3: To apply technologies for energy conservation, design for conservation of energy materials, Energy flow networks for employability and entrepreneurship skills.
CO4: Ability to evaluate the performance of industrial boilers, furnaces etc. by direct and indirect methods for employability and entrepreneurship skills.
CO5: Analyzing and Understanding of cogeneration in industry and waste heat recovery techniques and devices for skill development and employability and develops local and global interest.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	2	3	1	2	3	3	2	3	1	2
CO 2	3	3	2	3	3	2	3	2	3	3
CO 3	1	1	2	3	3	2	1	2	2	3
CO 4	3	3	2	3	3	2	3	2	3	3
CO 5	3	3	2	3	3	2	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)
(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill development	Employability	Entrepreneurship development
CO1	3	3	1
CO2	3	3	2
CO3	2	3	3
CO4	1	3	3
CO5	3	3	1

Suggested Readings:

1. Management / H. Koontz and CyrillDonnel / McGraw Hill
2. Financial Management -S. C. Kuchhal , Chaitanya Publishing House.
3. Energy Management Hand Book, Turner, W. C., Doty, S. and Truner, W. C., 7th edition, Fairmont Press, 2009.
4. Energy Management Principles, Smith, C. B., Pergamon Press, 2007
5. Energy Management, Murphy, W. R., Elsevier, 2007.

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- www.researchgate.net
- www.nsf.gov
- en.wikipedia.org
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