DIT UNIVERSITY

Dehradun

Detailed Course Structure & Syllabus

of

B.Tech. – Mechanical Engineering

(Fully Flexible Choice Based Credit System)

Approved by the Academic Council at its 14th Meeting held on 22.04.2020

Course Structure & Syllabus of B.Tech.– Mechanical Engg.
Applicable for Batch: 2020-24

Introduction

The Ministry of Human Resource Development (MHRD), Govt. of India, has initiated development of a New Education Policy (NEP) to bring out comprehensive reforms in the Indian education system.

The University Grants Commission (UGC) has subsequently initiated several steps to foster academic excellence through introduction of paradigm shift in learning and teaching pedagogy, innovation and improvement in course curricula, examination and education system.

While a majority of education institutions have started following the semester-based system of education, it has been observed that this new system is still producing graduates who lack knowledge, values, and skills and are not job ready professional. The reason for this lacking could be attributed to the rigidity of our program structures and lack of flexibility to have choices among core subject education, liberal arts, ability enhancement, skill development, etc., that is fundamental to overall development and employability of these graduates.

To make this possible, a fully flexible choice-based credit system (FFCBCS), a well-established internationally known system, is proposed. This fully flexible choice-based credit system allows students the flexibility to learn at their own pace, and register for both core subjects and a variety of courses from other areas, leading to holistic development of an individual. The FFCBCS will facilitate us to bench mark our programs with best international liberal arts based academic programs.

Advantages of the FFCBCS structure:

- Shift in focus from the teacher-centric to student-centric education. Student can curve out their program structure by choosing minimum number of credits from well-defined baskets.
- Student may undertake as many credits as they can cope with.
- FFCBCS allows students to choose courses from various baskets of inter-disciplinary, intra-disciplinary, skill oriented, ability enhancing, and from other disciplines.

Features unique to DIT University FFCBCS structure

1. A minimum of 150-160 credits has to be earned by a student to be eligible for an Under Graduate degree in Engineering. Each department will decide their total credits for each program, and it can vary across disciplines.

2. Courses are categorized into 11 baskets, and a student will have the option to choose courses in most baskets and earn ***minimum number of credits*** required in each basket for the award of his/her degree. For each basket, Engineering departments have the flexibility to identify course(s) which will be a core requirement for their program.

3. In certain disciplines, students may choose a ***Specialization*** by earning 18 credits of Discipline Elective courses towards a particular area of that discipline (interdisciplinary). In addition to this, brighter students will have the option to receive (a) a ***Certificate*** by earning *additional* 9 credits towards a particular area either inside or outside their discipline, or (b) ***Minor*** by earning additional 18 credits towards a particular area outside their discipline. Certificates and Minors can be earned through either University courses, or with MOOCs from providers as identified by the University. Each department will design the structures and eligibility conditions for registration to its certificates or minor program, which may be reviewed annually, to keep the ***Certificates*** and ***Minors*** contemporary and relevant to latest changes.

4. An FFCBCS council may be formed comprising all HoDs and one representative each from respective departments. FFCBCS council will meet at the end of every semester after the

completion of Board of Examination meeting to discuss and finalize course offerings by respective departments in the upcoming semester. FFCBCS council will be chaired by the Dean Academic Affairs.

5. To provide sufficient flexibility and room during the program for additional ***Certificates***, ***Specializations, and Minors***, 8-week summer semesters (Summer 1, Summer 2, and Summer 3) may have to run. Summer semesters are critical for implementing a fully flexible system. Each department will decide *a priori* which courses to offer in the summer semester and get them finalized at the FFCBCS council meeting.

6. Project based learning has to be incorporated as a core component of evaluation in each course, and depending on the level and type of the course, the project can be of several types - Study Oriented Project, Lab Oriented Project, Design Oriented Project, Computer Oriented Project, Projects of Organizational Aspects, Research Projects, or Entrepreneurship and Start Up Projects. A Capstone Project has been introduced in the 8th semester for all Bachelor of Technology students.

7. Courses under each basket may be updated on an annual basis.

8. Each student will be advised by a faculty advisor of his/her department for registration of courses from each basket in the beginning of semester, depending upon the availability of seats. A student advising centre may be formed where students will have access to department faculty advisers. Faculty advisers should have complete access to view individual student's academic transcript for advising purposes.

9. A student getting an F grade in a core course (departmental or otherwise) at the end of the semester will have to earn those credits by registering for the same course whenever it is offered in subsequent semesters. If the course is not a core course, the student may choose to register for any other course next semester in that basket as advised by the department faculty adviser. Additional fees for those number of credits may apply.

10. Students may opt for summer training/internships/industrial tours as advised by the department. However, these activities will not have credits.

Baskets of FFCBCS

11 baskets of courses have been identified to provide student comprehensive exposure to a large number of areas, leading to the holistic development of an individual. These baskets are as follows:

1. **Language and Literature:** These include courses related to English or other popular languages worldwide, communication skills, and literature. These courses are of 3 credits each.
2. **Core Science:** These courses include science courses from the disciplines of Physics and Chemistry. These courses are of 5 credits each.
3. **Core Mathematics:** This basket includes courses from Mathematics department, crafted for engineering students. These courses are of 4 credits each.
4. **Engineering Sciences:** This basket includes introductory courses from various disciplines of Engineering designed to provide the student solid foundation to the domain of engineering. These courses are of 4 credits each.
5. **Discipline Core:** This basket includes compulsory courses in the discipline in which the student is admitted to the University. These courses are of 4 credits each.
6. **Discipline Elective:** This basket provides students courses other than discipline core, and are normally in certain specialized areas. These courses are of 3 credits each.

7. **Humanities and Liberal Arts:** This basket includes liberal arts courses in various disciplines like psychology, management, economics, etc., and are of 3 credits each.
8. **Skill Enhancement:** Courses in this basket are primarily hands-on and aims to allow students acquire skills required in certain disciplines that are currently in high demand in the job market. These courses are of 2 credits each.
9. **Ability Enhancement:** These courses aim to enhance knowledge and ability of an individual in certain required areas related to national and societal interest. Courses in this basket are of 2 credits each.
10. **Free Electives:** Student can register for any three courses outside their department of his/her choice. These courses can also be taken from MOOCs, and a minimum of 9 credits have to be taken by a student in this basket.
11. **Capstone Project:** Capstone project is a semester long multifaceted experimental/research assignment that serves as a culminating academic and intellectual experience for students, taken in the last semester of study. It is of 12 credits and may be done groups of not more than three students, and in three modes as follows:
    - **Mode A**: Project with a department faculty.
    - **Mode B**: Project as part of Industry Internship arranged only by the career and placement service of the University. Students securing this assignment on their own will not be allowed, unless the project is secured at a well-known industry, and duly approved by the department. The department's decision in all such cases will be final.
    - **Mode C**: Semester long project in an academic institute/lab of National/International Importance, secured by students on their own. The department's decision to allow in all such cases will be final.

A separate rule booklet will be released for implementation of Capstone Project.

DIT University FFCBCS credits

Basket	Minimum number of DIT University Credits to be taken in each basket
Language and Literature (LL)	6
Core Sciences (CoS)	10
Core Mathematics (CM)	12
Engineering Sciences (ES)	24
Discipline Core (DC)	48
Discipline Elective (DE)	18
Humanities and Liberal Arts (HL)	9
Skill Enhancement (SEC)	8
Ability Enhancement (AEC)	6
Free Electives (FE)	9
Capstone Project (PRJ)	12
Total	**162**

Course Structure & Syllabus of B.Tech.– Mechanical Engg.
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Course Baskets: University FFCBCS Baskets (other than DC/DE) for B.Tech Programs.
A * against a course means it is a core course for all B.Tech students.

Course Code	FFCBCS Baskets (other than DC/DE)				
	Language and Literature (min 6 credits to be taken)	**Credits**			
	Name of Courses	L	T	P	C
LAF181	Professional Communication*	2	0	2	3
LAF182	Indian English Literature	3	0	0	3
LAF183	English Language Teaching	3	0	0	3
	Core Sciences (min 10 credits to be taken)				
	Name of Courses	L	T	P	C
CHF101	Engineering Chemistry (For CS/IT/EE/ECE)	3	1	2	5
CHF102	Applied Engineering Chemistry (for ME/CE/PE)	3	1	2	5
PYF101	Wave & Optics and Introduction to Quantum Mechanics	3	1	2	5
PYF102	Introduction to Mechanics	3	1	2	5
PYF103	Electricity & Magnetism	3	1	2	5
	Core Mathematics (min 12 credits to be taken)				
	Name of Courses	L	T	P	C
MAF101	Engineering Mathematics I *	3	1	0	4
MAF102	Engineering Mathematics II*	3	1	0	4
MAF201	Engineering Mathematics III (EE, ME, CE)	3	1	0	4
MAF202	Probability and Statistics (CSE, IT, ECE, PE)	3	1	0	4
	Engineering Sciences (min 24 credits to be taken)				
	Name of Courses	L	T	P	C
ECF101	Fundamental of Electronics Engineering.	3	0	2	4
EEF101	Basic Electrical Engineering	3	0	2	4
EEF143	Electrical and Electronics Engineering Practice (non EE/EECE)	3	0	2	4
MEF101	Thermodynamics*	3	1	0	4
CSF101	Programming for Problem Solving	3	0	2	4
CSF102	Data Structures	3	0	2	4
MEF102	Engineering Graphics*	2	0	4	4
MEF103	Engineering Mechanics*	2	1	2	4
MEF201	Mechanical Engineering Materials*	3	0	2	4
PEF204	Fluid Mechanics	3	0	2	4
EEF141	Electrical Engineering Materials	3	0	2	4
ECF142	Fundamental of Semiconductor Electronics	3	1	0	4
	Skill Enhancement (min 8 credits to be taken)				
	Name of Courses	L	T	P	C
MEFXXX	Technical Training 1	0	0	4	2
MEFXXX	Technical Training 2	0	0	4	2
MEFXXX	Value Added Training 1	0	0	4	2
MEFXXX	Value Added Training 2	0	0	4	2

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SWAYXXX	MOOCS Courses (as advised by the departments)	2	0	0	0
	Ability Enhancement (min 8 credits to be taken)				
	Name of Courses	L	T	P	C
CHF201	Environmental Science*	2	0	0	2
LAF285	Indian Constitution*	2	0	0	2
MEF483	Entrepreneurship and Start-ups*	0	0	4	2
UCF201	Aptitude and Soft Skills*	2	0	0	2
	Humanities and Liberal Arts (min 9 credits to be taken)				
	Name of Courses	L	T	P	C
LAF281	Introduction to Psychology	3	0	0	3
LAF381	Positive Psychology & Living	3	0	0	3
LAF481	Application of Psychology	3	0	0	3
LAF282	Human Values	3	0	0	3
LAF283	Literature, Language & Society	3	0	0	3
LAF284	Principles of Management	3	0	0	3
LAF482	Intellectual Property Rights	3	0	0	3
LAF382	Engineering Economics	3	0	0	3
	Free Electives (min 9 credits to be taken)				
	Name of Courses	L	T	P	C
ECF481	Analogue Electronics	2	0	2	3
ECF482	Cellular Communication Network	2	0	2	3
ECF381	Microcontroller	2	0	2	3
ECF382	Bio Medical Instrumentation	2	0	2	3
ECF483	Digital Image processing	2	0	2	3
CSF381	Software Project Management	3	0	0	3
CSF345	Introduction to Data Science	3	0	0	3
CSF482	Introduction to Cybersecurity	3	0	0	3
MEF381	Composites materials	3	0	0	3
MEF481	Total Quality Management	3	0	0	3
MEF482	Renewable Energy Sources	3	0	0	3
PEF 381	Carbon Capture and Sequestration	3	0	0	3
PEF 491	Polymer Technology	3	0	0	3
PEF 492	Health, Safety and Environment in Industry	3	0	0	3
CEF281	Properties of Materials	3	0	0	3
CEF382	Disaster Preparedness Planning & Management	3	0	0	3
CEF481	Environmental Management & Sustainability	3	0	0	3
CEF482	Natural Dynamics	3	0	0	3
CEF483	GIS	3	0	0	3
CEF484	Resource Dynamics and Economic Implications	3	0	0	3
	Project (12 credits)				
UCF439	Capstone Project	0	0	12	12

	Discipline Core (52 credits)					
	Name of courses	**Pre-Requisite**				
MEF202	Theory of Machines	MEF-102, MEF-103	2	1	2	4
MEF203	Applied Thermodynamics	MEF-101	3	1	0	4
MEF205	Fundamentals of I.C. Engines and Automobiles	MEF-101, MEF-203	2	1	2	4
MEF206	Strength of Materials	MEF-202	2	1	2	4
MEF207	Manufacturing Processes	MEF-201	3	0	2	4
MEF208	Fluid mechanics and Machines	MEF-103	2	1	2	4
MEF301	Design of Machine Elements	MEF-202, MEF-206	3	1	0	4
MEF302	Industrial Engineering	MEF-207	3	1	0	4
MEF303	Heat Transfer	MEF-205	2	1	2	4
MEF304	Refrigeration and Air Conditioning	MEF-303	2	1	2	4
MEF305	Measurement and Metrology	MEF-207	2	1	2	4
MEF306	Computer Aided Design	MEF-301	3	0	2	4
	Discipline Electives (18 credits)					
MEF341	Automotive Transmission System		2	1	0	3
MEF342	Vehicle Maintenance		2	0	1	3
MEF343	Design of Transmission System		2	1	0	3
MEF344	Automotive Electrical & Electronics		2	0	1	3
MEF345	Vehicle body Engineering		3	0	0	3
MEF346	Artificial Intelligence for Mechanical Engineering		3	0	0	3
MEF347	Fundamental of Robot Vision		3	0	0	3
MEF348	Robotics Engineering		3	0	0	3
MEF349	Robotics kinematics & dynamics		3	0	0	3
MEF350	Heat exchangers: Fundamentals and Design Analysis		3	0	0	3
MEF351	Robotics Simulation		2	0	1	3
MEF352	Manufacturing System Simulation		2	1	0	3
MEF353	Computational methods in thermal and fluid engineering		2	0	1	3
MEF354	Power Plant Engineering		3	0	0	3
MEF441	Advanced Automobile Technology		3	0	0	3
MEF442	TURBOMACHINES		3	0	0	3
MEF443	Machine Tool Design		3	0	0	3
MEF444	Operation Research		2	1	0	3
MEF445	Tribology		3	0	0	3
MEF446	Product Design & Development		3	0	0	3
MEF447	Design of Hydraulics & Pneumatics systems		2	0	1	3
MEF448	Computer Integrated Manufacturing		2	0	2	3

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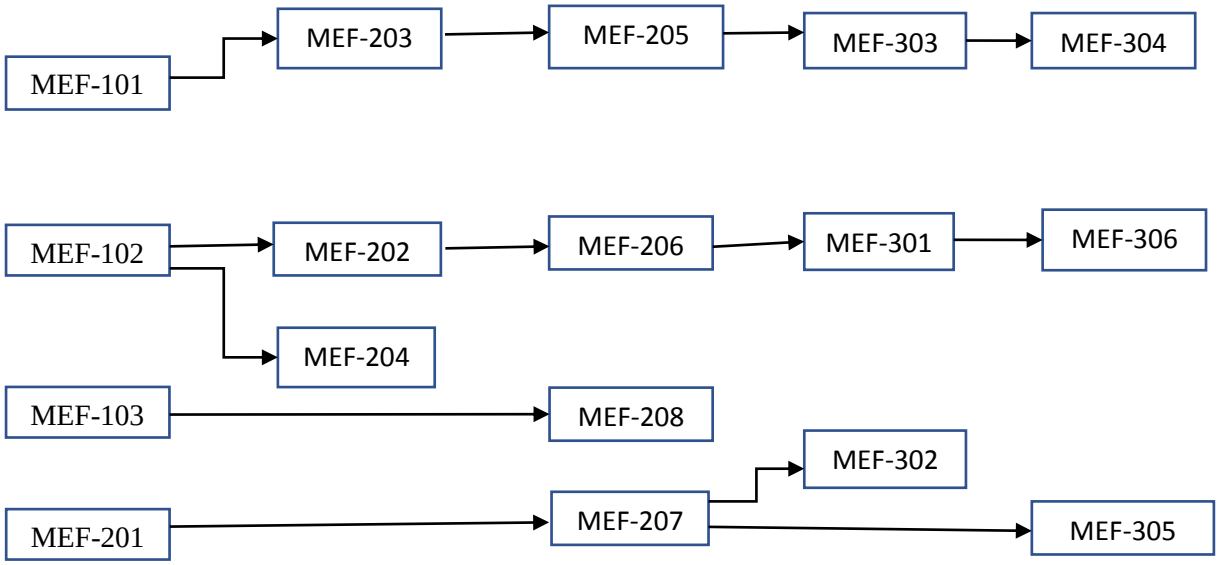

Discipline core subjects flow chart

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After release of Final Exam results, Academic Advisory Committee meets to decide & finalize course offerings in each basket

Courses are created in SAP and in LMS with required number of seats

Registrar announces the date for Registration

Students get advised and registers for courses in the Student Advising Centre

List of students gets added in LMS

Class Starts

<u>Flow of Actions for implementing FFCBCS every semester</u>

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UNDERGRADUATE COURSE DESCRIPTION DOCUMENT

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF181**
3. Course Title	**Professional Communication**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:2**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Language and Literature**

8. Course Summary

This course is to enhance the Communication Skills of the students. It also focuses on Basic facets of communication. It introduces the students to LSRW and Non-verbal Language and how to master these aspects to be an effective communicator.

9. Course Objectives

The course aims at developing the LSRW skills of students for effective communication. Also to equip them for a business environment. It also focusses at preparing the students understand and present themselves effectively.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Communicate smoothly
2. Greater self-confidence and knowledge of life skills helps them to develop healthier interpersonal relationships.
3. Present themselves effectively
4. Prepares the students to face future challenges and excel in their personal and professional lives.

11. Curriculum Content

Unit 1: Communication

Communication: Meaning, Types of Communication: General & Technical Communication
Knowledge and adoption of Non Verbal cues of communication: Kinesics, Proxemics, Chronemics, Oculesics, Haptics, Paralinguistics, Barriers to Communication, Overcoming strategies.

Unit 2: Listening & Speaking Skills

Listening Comprehension: identifying General & Specific information, Note taking and drawing inferences

Introduction to Phonetics: Articulation of consonants and vowel sounds.

Unit 3: Reading Skills & Technical Writing Skills

Reading Strategies and Vocabulary Building Reading Comprehension, Paragraph development, Intra office Correspondence: Notice, Agenda, Minutes and Memorandum Technical Proposal & Report

Unit 4: Communication at Work

Business Letter Writing, Job Application Letter & Resume, Interview Skills, Impression Management, SWOT Analysis (Identifying Strength & Weakness), EQ and Its Dimensions

Textbook(s)

1. Rizvi, Ashraf. Effective Technical Communication, McGraw Hill, New Delhi. 2005.
2. Raman, Meenakshi and Sangeeta Sharma,. Technical Communication: Principles and Practice, 2nd Edition. New Delhi: Oxford University Press. 2011.

Reference Books

1. Aslam, Mohammad. Introduction to English Phonetics and Phonology Cambridge.2003.
2. Ford A, Ruther. Basic Communication Skills; Pearson Education, New Delhi.2013.
3. Gupta, Ruby. Basic Technical Communication, Cambridge University Press, New Delhi.2012.
4. Kameswari, Y. Successful Career Soft Skills and Business English, BS Publications,
5. Hyderabad.2010.
6. Tyagi, Kavita& Padma Misra. Basic Technical Communication, PHI, New Delhi. 2011.
7. Ghosh, B. N. Managing Soft skills for Personality development,Laxmi Publications Ltd., New Delhi, 2013.
8. Elizabeth B. Hurlock. Personality Development , TMH Publication,2010

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Assignments, Class Tests etc. will be done. Various teaching methods like Discussion Method, Case Study Method and Lecture Method will be adopted.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF182**
3. Course Title	**Indian English Literature**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Language and Literature**

8. Course Summary

- Indian English Literature is an honest enterprise to demonstrate the ever rare gems of Indian Writing in English. From being a singular and exceptional, rather gradual native flare – up of geniuses, Indian Writing has turned out to be a new form of Indian culture and voice in which India converses regularly. This course will introduce various authors and will help to understand the role of literature in reflecting the social context and the shaping of a young nation.

9. Course Objectives

- The course will enable the students to understand the level of Indian English Literature.
- It will also enable the students to understand different genres such as prose, poetry, and fiction in Indian Writers in English.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

Course Outcome:

- The students will develop an insight into Indian literature.
- The students will learn to appreciate different genres of literature of Indian Literature in English.
- The students will understand the role of literature in reflecting the social context and the shaping of a young nation.
- The students will demonstrate knowledge and comprehension of major texts and traditions of language and literature written in English as well as their social, cultural, theoretical, and historical contexts.

11. Curriculum Content

Unit 1

Prose

APJ Abdul Kalam: Unity of Minds

Swami Vivekananda: The Cosmos-Macrocosm

Mahatma Gandhi: Hind Swaraj, What is Civilization? (Chapter XIII) Education (Chapter XVIII)

Unit II

Poetry

Toru Dutt:	Our Casuarina Tree
Rabindranath Tagore:	Geetanjali – Where the mind is without fear
Sri Arbindo:	Stone Goddess
Sarojani Naidu:	Life
Nissim Ezekiel:	The Night of Scorpion
Kamla Das:	An Introduction

Unit III

Short Stories

R.N.Tagore:	Kabuliwala
Mulk Raj Anand:	Duty
R.K. Narayan:	An Astrologer's Day
NayantaraSehgal:	Martand

Unit IV

Novel

Ruskin Bond: Flights of Pigeons

Textbook(s).

1. Kumar, Shiv K. (ed),Contemporary Indian Short Stories in English, 2007 SahityaAkademi.
2. Anand, Mulk Raj; SarosCowasjee (ed.);Selected Short StoriesPenguin Books, 2006
3. Bond, Ruskin. Flights of Pigeons, Penguin Books, 2003

Reference Books

1. Tagore, Rabindra. *Nationalism*. Delhi: Rupa Publications, 1992.Print.
2. Chinhade, Sirish. *Five Indian English Poets*. New Delhi: Atlantic Publishers and Distributors, 1996.Print.

3. Naik, M.K. *A History of Indian English Literature*. New Delhi: SahityaAkademi, 2004.Print.
4. Agrawal, K.A. Ed. *Indian Writing In English: A Critical Study*. Atlantic Publishers &Dist, 2003.Print.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF183**
3. Course Title	**English Language Teaching (ELT)**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Language and Literature**

8. Course Summary

This course will offer a historical perspective to the teaching of English as a second language. It will trace the changes in language teaching methods throughout history depending on changes in the kind of proficiency learners need. It includes the different approaches used over the years and their application in teaching English as a second language in the classroom. It also traces the status of English language and the 'World English' and how it affects the teaching of English.

9. Course Objectives

To introduce students to the nature of English language learning and its theoretical implications. The main objective of the course is to enable students to evaluate a variety of language learning methods and approaches. It also aims to empower students to understand ELT in their contexts of language learning.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Students will learn about communicative approaches to English language teaching.
2. Be able to understand the theories and methodologies of ELT
3. Be able to explore core components of communicative language teaching
4. Students will learn to apply ELT theories

11. Curriculum Content

Unit 1

Historical Perspective , ELT and its beginnings: development of reading approach, oral method and audio-lingual method

Unit 2

Communicative Language Teaching (CLT): the concept of 'communicative competence; ESL in India: a historical trajectory

Unit 3

Halliday's notion of 'transitivity' and 'meta-functions'

Corpus Linguistics ELT: corpus studies and how it can be used for language teaching

Unit 4

'World English' and ELT, Model of the 'Concentric Circles' and its impact on ELT

Textbook(s)

1. Maybin, Janet and Swann, Joan. (2009). The Routledge Companion to English Language Studies. London: Routledge, Print

Reference Books

1. Richards, J. & T.S. Rogers. (1986). Approaches and Methods in Language Teaching. Cambridge: Cambridge University Press, Print.
2. Ur, Penny. (1996). A Course in Language Teaching: Practice and Theory. Cambridge: Cambridge University Press, Print.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Physics**
2. Course Code	**PYF101**
3. Course Title	**Wave & Optics and Introduction to Quantum Mechanics**
4. Credits (L:T:P:C)	**3:1:2:5**
5. Contact Hours (L:T:P)	**3:1:2**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

8. Course Summary

9. Course Objectives

The objective of this course is to develop a fundamental basis of waves, optical phenomenon, concepts of quantum mechanics and semiconductor physics which the engineering students can apply to their respective area of specialization.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. To acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature.
2.To be able to identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.
3. To be able to make approximate judgments about optical and other wave phenomena when necessary.
4. To acquire skills allowing the student to organize and plan simpler laboratory course experiments and to prepare an associated oral and written report.
5. To have basic knowledge of Quantum Mechanics and Semiconductors.Curriculum Content

Unit 1:

Mechanical and electrical simple harmonic oscillators (characteristics and energy), damped harmonic oscillator, forced mechanical and electrical oscillators, impedance.

Unit 2:

Transverse wave on a string, the wave equation on a string, harmonic waves, reflection and transmission of waves at a boundary, standing waves and their eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves (Newton formula and Laplace correction).

Unit 3:

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, fringes with white light, interference in parallel thin films, Newton's rings, Fraunhofer diffraction from a single slit & N- slits, Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

Unit 4:

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by

population inversion, components of LASER and pumping methods (in brief), different types of lasers: gas lasers (He-Ne), solid-state laser (ruby)

Unit 5:

Wave nature of particles, Phase velocity, wave-packet and group velocity, Uncertainty principle and its applications, time-dependent and time-independent Schrodinger equation, physical significance of wave function., Solution of stationary-state Schrodinger equation for one dimensional problem– particle in a box, potential barrier.

Textbook(s)

1. N. K Bajaj, Physics of Waves and Oscillations,Tata McGraw-Hill, 2008
2. AjoyGhatak, Optics, McGraw Hill Education, 2017.
3. D. J. Griffiths, Quantum mechanics, Pearson Education, 2015.

Reference Books

1.H. J. Pain, The physics of vibrations and waves, Wiley, 2008

2.E. Hecht, Optics, Pearson Education, 2008

SR.NO.	LIST OF EXPERIMENTS
1	(a) To determine wavelength of sodium light using Newton's Rings. (b) To determine the refractive index of a liquid using Newton's Rings.
2	To determine wavelength of sodium light using Fresnel's Biprism.
3	(a) To determine wavelength of prominent lines of mercury using plane diffraction grating. (b) To determine the dispersive power of a plane transmission diffraction grating.
4	To determine the specific rotation of cane sugar solution using bi-quartz polarimeter
5	To study the diffraction pattern of Single slit and hence determine the slit width.
6	(a) To verify cosine square law (Malus Law) for plane polarized light. (b) To study the nature of polarization using a quarter wave plate.
7	To study the variation of refractive index of the material of the prism with wavelength and to verify Cauchy's dispersion formula
8	(a) To study photoelectric effect and determine the value of Planck's constant. (b) To verify inverse square law using photocell.
9	To determine the frequency of AC mains using sonometer.
10	To determine the frequency of AC mains or of an electric vibrator by Melde's experiment
11	To measure the numerical aperture (NA) of an optical fiber.

11. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Assignments, Class Tests etc. will be done. Various teaching methods like Discussion Method, and Lecture Method will be adopted.

1. Department offering the course	**Physics**
2. Course Code	**PYF102**
3. Course Title	**Introduction to Mechanics**
4. Credits (L:T:P:C)	**3:1:2:5**
5. Contact Hours (L:T:P)	**3:1:2**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

8. Course Objectives

Mechanics lies at the foundation of physics and along with an appreciation of the molecular structure of matter exposes the student to the phenomenology of physics.

9. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. To know Newton's laws of motion, potentials, conservation of energy, momentum and angular momentum, and be able to apply them to projectiles, circular motion, and gravity
2. Demonstrate an understanding of intermediate mechanics topics such as co-ordinate transformations, oscillatory motion, gravitation etc.
3. Demonstrate rigid body and rotational dynamics using the concept of angular velocity and momentum.
4. Understand the concept of non-inertial frames of reference, coriolis and centripetal accelerations and their applications.
5. Understand the concept of elastic constants and demonstrate bending of beams.

10. Curriculum Content

Unit 1:

Transformation of scalars and vectors under Rotation transformation; Newton's laws and its completeness in describing particle motion, Cylindrical and spherical coordinatesMechanics of a system of particles, conservation of laws of linear momentum, angular momentum and mechanical energy, centre of mass and equation of motion, Constraints and degrees of freedom.

Unit 2:

Potential energy function; F = - Grad V, Equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum and areal velocity; Elliptical, parabolic and hyperbolic orbits

Unit 3:

Non-inertial frames of reference; Rotating frames of reference, Coriolis force; Applications: Weather systems, projectile motion

Unit 4:

Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance, Kater's Pendulum and bar pendulum.

Unit 5:

Rotation of rigid body, Moment of Inertia, Torque, angular momentum, kinetic energy of rotation, Theorems of perpendicular and parallel axis, Moment of Inertia of rectangular rod, spherical and cylindrical bodies. Acceleration of a body moving on horizontal and inclined plane. Moment of inertia of Fly Wheel.

Unit 6:

Elastic constants- Introduction and relationship between elastic constants, Cantilever, Beam, Bending of beam, Twisting of a cylindrical body.

Textbook(s)

1. Mechanics – D.S. Mathur, S. Chand & Co., 2012.
2. Introduction to Mechanics –D.Kleppner&R.Kolenkow, Cambridge University Press, 2017

Reference Books

1. Analytical Mechanics, G.R. Fowles and G.L. Cassiday., Cengage Learning India Pvt. Ltd., 2006

2. Introduction to Special Relativity, R. Resnick, John Wiley and Sons, 2007

3. Principles of Mechanics — J.L. Synge & B.A. Griffiths, Andesite Press, 2015

SR.NO.	LIST OF EXPERIMENTS
1	To measure internal diameter, external diameter and depth of a vessel using vernier calipers
2	To measure density of a wire using screw gauge.
3	To determine the Moment of Inertia of a Flywheel
4	To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
5	To determine the Modulus of Rigidity of a Wire by Maxwell's needle
6	To determine the elastic Constants of a wire by Searle's method
7	To determine the value of g using Bar Pendulum
8	To measure the Young's Modulus using Bending of Beam
9	To determine the value of g using Kater's Pendulum

10	To determine the moment of inertia of a body using Torsion pendulum

11. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Assignments, Class Tests etc. will be done. Various teaching methods like Discussion Method, and Lecture Method will be adopted.

1. Department offering the course	**Physics**
2. Course Code	**PYF104**
3. Course Title	**Introduction to Electromagnetic Theory**
4. Credits (L:T:P:C)	**3:1:2:5**
5. Contact Hours (L:T:P)	**3:1:2**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

8. Course Summary

9. Course Objectives

To teach students the effects of electric charges at rest and in motion. Both positive and negative charges produce force field which is called “electric field”. Moving charges produce current, which gives rise to another force field called “magnetic field”. The electromagnetic theory studies the behavior of the electric and magnetic fields.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. The use of Coulomb's law and Gauss' law for the electrostatic force
2. The relationship between electrostatic field and electrostatic potential
3. The use of the Lorentz force law for the magnetic force
4. The use of Ampere's law to calculate magnetic fields
5. The use of Faraday's law in induction problems
6. The basic laws that underlie the properties of electric circuit elements

Unit 1: Electrostatics in vacuum

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Gauss law and its applications, Laplace’s and Poisson’s equations; Practical examples like Faraday’s cage and coffee-ring effect; energy of a charge distribution and its expression in terms of electric field.

Unit 2: Electrostatics in a linear dielectric medium

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; gauss law in dielectrics; Polarization vector, solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field. Energy in dielectrics system

Unit 3:Magnetostatics

Electric current and current density, magnetic force, continuity equation, Bio-Savart law and its applications(straight wire and solenoid), Divergence and curl of static magnetic field; Ampere

circuital law and its applications(wire, solenoid & toroid), current loop as magnetic dipole and dipole moment, Para, dia and ferro magnetic materials (properties only)

Unit 4: Faraday's law

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Unit 5: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations

Concept of displace current, Modifying equation for the curl of magnetic field to satisfy continuity equation; and magnetic field arising from time-dependent electric field; Maxwell's equation in integral and differential form in vacuum and non-conducting medium; transverse nature of EM wave, Wave equation in free space, Wave propagation in conducting medium and non conducting medium & skin depth, Flow of energy and Poynting vector.

Textbook(s)

1. David Griffiths, Introduction to Electrodynamics, PHI Learning, 2012.

Reference Books

1. Halliday and Resnick, Physics, Wiley, 2013.
2. W. Saslow, Electricity, Magnetism and Light,Academic Press, 2002.

SR.NO.	LIST OF EXPERIMENTS (ANY TEN)
1	Identification of various electronic components.
2	Use of multimeter for testing diodes, LEDs, transistors and measurements of resistance, capacitance, inductance, dc voltage, dc current, ac voltage, ac current and frequency of ac mains.
3	Charging and discharging of capacitor through resistance and determination of time constant.
4	To determine the specific resistance of a given wire using Carey Foster's bridge.
5	To verify Stefan's law by electrical method.
6	To study the variation of magnetic field with distance along the axis of a current carrying coil and determination of radius of the coil.
7	To calibrate the given voltmeter using potentiometer.
8	To calibrate the given ammeter using potentiometer.

9	To determine the bandgap of a semiconductor p-n junction.
10	To determine the resistance of a sample using four probe method.
11	To determine the band gap of semiconductor using four probe method.
12	To determine a unknown resistance using Wheatstone bridge.

11. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Assignments, Class Tests etc. will be done. Various teaching methods like Discussion Method, and Lecture Method will be adopted.

1. Department offering the course	**Department of Chemistry**
2. Course Code	**CHF101**
3. Course Title	**Engineering Chemistry**
4. Credits (L:T:P:C)	**3:1:1:5**
5. Contact Hours (L:T:P)	**3:1:2**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Science Elective**

8. **Course Summary:** It covers fundamentals of Chemistry required for the engineering students.

9. Course Objectives: The objective of the course is to provide a summery on water treatment, Fuels, green chemistry and synthetic chemistry. The course is specifically designed for CSE& IT students to give them an overview of the working principles, mechanisms, reactions and applications of the building blocks of batteries, cells and surface coatings to protect the metal.

10. Course Outcomes:

At the end of the course student will get:

CO1: To understand about the treatment of water, sewage water and hardness related calculations.

CO2: An overview of of the working principles, mechanism of reactions and applications of cells, electrodes and batteries.

CO3: An overview of different types, mechanism of corrosion its prevention and surface coatings.

CO4: The concept of different types of fuel, lubricants. They will understand about their applications in various industries and also about latest development in the field of alternative fuels.

CO5: aware of how chemical processes can be designed, developed and run in a sustainable way. Students acquire the competence to think of chemistry as a sustainable activity.

11. Curriculum Content:

Unit 1: Water Treatment and Analysis **(08 Lectures)**

Standards for drinking water, Water Quality parameters, Determination of alkalinity of water, Hardness of water: Units and determination. Demineralization of water, softening of water: Lime-soda Process, Ion exchange process, Zeolite process and RO process. Internal conditioning methods: Carbonate conditioning, Phosphate conditioning, Colloidal conditioning, Calgon conditioning. Desalination of brackish water

Unit 2: Electrochemistry **(06 Lectures)**

Migration of ions, Transference number, Determination of Transference number by Hittorf`s method, Conduct metric titrations, Types of electrode: Calomel and glass electrode, Battery.

Unit 3: Corrosion **(06 Lectures)**

Corrosion and its economic aspects, Types of corrosion: Galvanic, Erosion, Crevice, Pitting, Waterline, Soil, Microbiological. Theories of corrosion: Acid, Direct Chemical attack, Electrochemical. Corrosion prevention by metallic, organic/inorganic coatings and corrosion inhibitors

Unit 4: Fuels, Lubrication **(08 Lectures)**

Classification of fuels, Calorific value, Cetane number, Octane number, fuel quality, Comparison of solid, liquid and gaseous fuel, properties of fuel, alternative fuels: Biofuels, Power alcohol, Introduction of Lubricants, Functions of Lubricants, Classification of lubricants, Mechanisms of Lubrication, Properties of Lubricants.

Unit 5: Green Chemistry **(08 Lectures)**

Emergence of green chemistry, twelve principle of green chemistry, Use of alternative Feedstock (biofuels), Use of innocuous reagents, use of alternative solvents, design of safer chemicals, designing alternative reaction methodology, minimizing energy consumption

Text Books Recommended:

1. Engineering Chemistry by Shikha Agarwal. Cambridge University Press Edition 2015.
2. Engineering Chemistry by S. Vairam & Suba Ramesh. Wiley India Pvt. Ltd. 2014.

Reference Books:

1. Environmental Chemistry by Stanley E. Manahan. CRC Press Taylor and Francis.
2. Organic Chemistry by Morrison and Boyd. Pearson.
3. Physical Chemistry by Atkins. Oxford University Press.
4. Concise Inorganic Chemistry by J.D. Lee. Oxford University Press.

LIST OF PRACTICALS

1. Determination of alkalinity in the given water sample.
2. Estimation of temporary and permanent hardness in water sample using EDTA as standard solution.
3. Calculation of percentage of available chlorine in bleaching powder.
4. Chloride content in the given water sample by Mohr's method.
5. Determination of iron content in the given ore by using external indictor
6. pH-metric titration.
7. Proximate Analysis of coal sample
8. Flash and Fire point determination of a Lubricant

9. To determine the DO in a given water sample
10. Viscosity of a lubricant by Redwood Viscometer

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Department of Chemistry**
2. Course Code	**CHF102**
3. Course Title	**Applied Engineering Chemistry**
4. Credits (L:T:P:C)	**3:1:1:5**
5. Contact Hours (L:T:P)	**3:1:2**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Science Elective**

8. **Course Summary:**It covers fundamentals of Chemistry required for the engineering students.

9. Course Objectives: The objective of the course is to provide a summery on water treatment, Fuels, green chemistry and synthetic chemistry. The course is specifically designed for non CSE students to give them an overview of the working principles, mechanisms, reactions and applications of the building blocks of batteries, cells and surface coatings to protect the metal.

10.Course Outcomes:

At the end of the course student will get:

CO1: To understand about the treatment of water, sewage water and hardness related calculations.

CO2: An overview of electrical properties of the metals and detailed knowledge of semiconductors.

CO3: The basic fundamental behind selection of engineering materials and their properties required depending on their applications.

CO4: The concept of different types batteries and their applications.

CO5: Aware of how chemical processes can be designed, developed and run in a sustainable way. Students acquire the competence to think of chemistry as a sustainable activity.

11. Curriculum Content:

Unit 1 Water Technology (08 Lectures)

Standards for drinking water, Water Quality parameters, Demineralization of water, softening of water: Lime-soda Process, Ion exchange process, Zeolite process and Reverse Osmosis process. Internal conditioning methods: Carbonate conditioning, Phosphate conditioning, Colloidal conditioning, Calgon conditioning, Desalination of brackish water, sterilization of water.

Unit 2 Conductivity of solids (06 Lectures)

Introduction, Electrical properties of solids, Band theory of solids, Types of energy bands, Application of band theory to solids, Elemental semiconductors, Non-elemental semiconductors, Non-stichiometric n-type semiconductors, Chalcogen semiconductors

Unit 3 Engineering Materials (10 Lectures)

Introduction of polymers; Classification of Polymers; Functionality; Mechanism of Polymerization; Plastics; Individual Polymers; LDPE, HDPE, PVC, Polystyrene, Bakelite, Teflon, PMMA, PET, Nylon-6, Rubbers (BUNA-S and BUNA-N); Specialty Polymers (Conducting Polymers, Silicones and Polycarbonates), Gypsum, Plaster of Paris, Insulating Materials

Unit 4 Battery Technology (06 Lectures)

Battery, Photovoltaic cell, Metal-air battery, Lithium and nickel battery

Unit 5 Green Chemistry (08 Lectures)

Emergence of green chemistry, Twelve principle of green chemistry, Use of alternative Feedstock (biofuels), Use of innocuous reagents, use of alternative solvents, design of safer chemicals, designing of alternative reaction methodology, minimizing energy consumption.

Text Books Recommended:

1. Engineering Chemistry by Shikha Agarwal. Cambridge University Press Edition 2015.
2. Engineering Chemistry by S. Vairam&Suba Ramesh. Wiley India Pvt. Ltd. 2014.

Reference Books:

1. Environmental Chemistry by Stanley E. Manahan. CRC Press Taylor and Francis.
2. Organic Chemistry by Morrison and Boyd. Pearson.
3. Physical Chemistry by Atkins. Oxford University Press.
4. Concise Inorganic Chemistry by J.D. Lee. Oxford University Press.

LIST OF PRACTICALS

1. Determination of alkalinity in the given water sample.
2. Estimation of temporary and permanent hardness in water sample using EDTA as standard solution.
3. Calculation of percentage of available chlorine in bleaching powder.
4. Chloride content in the given water sample by Mohr's method.
5. Determination of iron content in the given ore by using external indictor
6. pH-metric titration.
7. Proximate Analysis of coal sample
8. Flash and Fire point determination of a Lubricant
9. To determine the DO in a given water sample

10. Viscosity of a lubricant by Redwood Viscometer

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mathematics**
2. Course Code	**MAF101**
3. Course Title	**ENGINEERING MATHMATICS-I**
4. Credits (L:T:P:C)	**3:1:0:4**
5. Contact Hours (L:T:P)	**3:1**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

OBJECTIVE: To introduce the fundamentals in Differential, Integral and Vector Calculus relevant to engineering applications.

Unit I

Review of Limit, Continuity and differentiation, Successive Differentiation, Leibnitz theorem

(without proof), Problems based on Leibnitz's theorem, Maclaurin's series in one variable, Taylor's expansion in one variable, Asymptote & Curvature, Point of inflexion, Double Points, Cusp, Node andconjugate points, Curve tracing for Cartesian curves.

Unit II

Partial differentiation and problems, Euler's theorem and its proof, Problems based on Euler's

theorem, Few corollaries on Euler's theorem for higher order derivatives and problems based on them, Taylor's expansion of a function in two variables, Jacobians, its properties, and transformations of coordinates,Maxima and minima of a function in two variables, Method of Lagrange's multipliers and problems.

Unit III

Double and triple integrals, Change of order of integration, Change of variables, Application of

integration to lengths, Surface, areas and Volumes- Cartesian and Polar coordinates. Beta and Gammafunctions, Dirichlet's integral and its applications.

Unit IV

Scalar and Vector fields, Vector differentiation, Directional derivatives Gradient, Divergence

and curl and their physical significance. Evaluation of Line integral, Green's theorem in plane (withoutproof), Stokes theorem (without proof), Gauss Divergence theorem (without proof) and problems basedon them.

LEARNING OUTCOME: Students will be able to:

- Use techniques for determining area under a curve, extrema of functions and their use in drawing graphs.
- Compute partial derivatives of functions of two or more variables and use them for determining extrema, saddle points of the surfaces of given functions.
- Use vector calculus in determining motions of fluids, work done by a force etc..
- Theorems like Greens theorem, Diverges theorem, Stocks theorem and their applications in determining surface area and volume.

Text Books:

1. G. B. Thomas Jr. & R. L. Finney, Calculus and Analytic Geometry, 9th Edition, Pearson Education
2. R. K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, 2nd edition, Narosa Publishing
   House, New Delhi, India,2006

Reference Books:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, U.K., 2006.

1. Department offering the course	**Mathematics**
2. Course Code	**MAF102**
3. Course Title	**ENGINEERING MATHMATICS-II**
4. Credits (L:T:P:C)	**3:1:0:4**
5. Contact Hours (L:T:P)	**3:1**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

OBJECTIVE: To introduce the fundamentals in Matrices and Linear Algebra, Ordinary Differential Equations, Laplace Transform and Infinite Series relevant to engineering applications.

UNIT I

Elementary row operations, row reduced Echelon form, rank of a matrix, invertible matrices,

Consistency of linear system of equations and their solution, Linear independence and dependence of vectors, Vector Spaces and its basis, Linear Transformations, Eigenvalues and Eigenvectors, Cayley-HamiltonTheorem, Diagonalization of matrices.

UNIT II

Order, degree of ODE and some basic concepts such as linearity and nonlinearity, general so-

lution and particular solution, formation of ODEs, First order differential equation: variable separablemethod, homogeneous method, and its variants, Linear differential equation of second order with constantcoefficients: Complementary function and particular integral for some standard functions, Cauchy Eulerlinear differential equation, Solution of second order linear differential equation with variable coefficients,method of variation of parameters, solution of simultaneous linear differential equations.

UNIT III

Laplace transform of some standard functions, Properties of Laplace transform, Inverse Laplace

transforms, Properties of Inverse Laplace transforms, using partial fractions for inverse Laplace transforms,Convolution theorem (without proof), Application of Laplace transforms to solve various types of differential equation, e.g., differential equations with constant coefficient, variable coefficients, simultaneousdifferential equations.

UNIT IV

Introduction to sequence and series, series of positive terms, comparison test, D'Alembert's ratio test, Root Test, Alternatingseries, Leibnitz test.Fourier series of periodic functions, Euler's formulae, functions having arbitraryperiod, change of intervals, even and odd functions, half range sine and cosine series.

Outcome: Students will be able to:

- Differentiate between invertible and singular matrices, determine characteristic equations of a matrix and hence eigen values and eigen vector for a given matrix.
- Determine differential equations satisfied by various physical application and their solutions.
- Use properties of improper integrals to define Laplace Transforms and use them to solve initial value physical problems
- Mathematically deal with infinite series and test their convergence.

Text Books:

1. R. K. Jain & S. R. K. Iyenger, Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, India, 2006.
2. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, U.K., 2006.

Reference Books:

1. W. E. Boyce and R. Di Prima, Elementary Differential Equations, (8th Edition), John Wiley & Sons, U.K., (2005).
2. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publication, New Delhi, India, 2012

1. Department offering the course	**Mathematics**
2. Course Code	**MAF201**
3. Course Title	**ENGINEERING MATHMATICS-III**
4. Credits (L:T:P:C)	**3:1:0:4**
5. Contact Hours (L:T:P)	**3:1**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

OBJECTIVE: Introduce the fundamentals in Complex variable.Solving Partial Differential Equations. Legendre polynomial of first kind with properties.Bessel function of first kind and its properties.

UNIT I

Series solution of ODE of 2nd order with variable coefficient with special emphasis to Legendre and Bessel differential equation by Frobenious method, Legendre polynomial of first kind, Bessel function of first kind and their properties.

UNIT II

Introduction and formation of Partial Differential Equations, Classification of Partial Differential

Equations, Solution of first order linear partial differential equations of the form Pp + Qq = R, LinearPDE with constant coefficients of IInd order. Method of separation of variables, Solution of wave equationin one dimension, Solution of heat in one dimension and Laplace equation using method of separation ofvariables.

UNIT III

Concept of Limit, continuity, and differentiability, Analytic functions, C-R equations and har-

monic functions, Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula for derivatives of analytic function. Representation of a function by power series, Taylor's andLaurent's series, R Singularities, zeroes and poles, Residue theorem, evaluation of real integrals of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\,d\theta$ and $\int_{-\infty}^{\infty} f(x)\,dx$.

UNIT III

Fourier integral; Fourier transform; Fourier sine and cosine transform; linearity, scaling, fre-

quency shifting and time shifting properties; convolution theorem. Z-transform; properties of Z-transforms; Convolution of two sequences; inverse Z-transform. Applications of Fourier Transform and Z-Transform.

Outcome: The student will be able to use

- Familiarity with methods to solve partial differential equations.
- Differentiation and Integration of complex functions to physical problems.
- Complex integration for solving real integrals.
- Fourier and Z-transform rules to physical problems.

Text Books:

1. J.W. Brown & R. V. Churchill: Complex Variables & Applications, 9th edition, McGraw-Hill, 2013.
2. R. K. Jain & S. R. K. Iyenger, Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, India, 2014.

Reference Books:

1. B. S. Grewal, Higher Engineering Mathematics, 42th Edition, Khanna publication, New Delhi, India, 2012.
2. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, U.K., 2006.

1. Department offering the course	**Mathematics**
2. Course Code	**MAF202**
3. Course Title	**Probability and Statistics**
4. Credits (L:T:P:C)	**3:1:0:4**
5. Contact Hours (L:T:P)	**3:1**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Core Sciences**

OBJECTIVE: The objectives of the course are to familiarize the students with statistical techniques, to equip them with standard concepts and, to learn tools of probability theory to solve engineering problems.

Unit I: Descriptive Statistics and Probability

Review of mean, median and mode, variance. Moments and properties, Skewness and Kurtosis. Probability: concepts, definition, examples, conditional probability and Bayes' theorem.

Unit II: Random Variables and Probability Distributions

Discrete & continuous random variables and their properties, mass function, density function, distribution functions. Expectation, moment generating function, Binomial, Poisson, Exponential & Normal distributions and their applications.

Unit III: Correlation and Regression

Bivariate distributions and their properties, Joint and marginal density functions, Conditional densities. Covariance, Correlation, Regression, Regression lines. Curve fitting by the method of least square- fitting of straight lines.

Unit IV: Hypothesis Testing

Population and samples, Sampling distribution of statistic, standard error. Null and Alternative Hypothesis, critical region, critical values and level of significance. One tail and two-tail tests, confidence interval, Errors in testing of hypothesis; Type I and Type II errors, power of the test.

Unit V: Inferential test procedures

Test of significance, large sample test for single proportion, difference of proportion, single mean, difference of means and difference of standard deviation. Small sample test: Student’s t-test and it’s applications, F-test and it’s applications. Chi-square test for goodness of fit and independence of attributes.

LEARNING OUTCOME: Students will be able to:

- Compute probability, various discrete and continuous probability distributions of random variables and their properties.
- Use the tools of statistics including measures of central tendency, correlation and regression.
- Use statistical methods for studying data samples.
- Use large sample and small sample tests.

Text Books:

1. S. Palaniammal, Probability and Random Processes, PHI learning private ltd., 2015.
2. S.C. Gupta, Fundamentals of Statistics, 7th Ed., Himalaya Publishing House, 2018.

Reference Books:

1. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2016.
2. Richards A Jonson, Irvin Miller and Johnson Freund, Probability and Statistics for Engineering, 9th Edition, PHI, 2011.
3. S. Ross, A First Course in Probability, 8th Ed., Pearson Education India, 2010.
4. M.R. Spiegel, J.J. Schiller and R.A. Srinivasan, Probability and Statistics, Schaum's Outlines, 2013.

13. Department offering the course	**Mechanical Engineering**
14. Course Code	**MEF101**
15. Course Title	**Thermodynamics**
16. Credits (L:T:P:C)	**3:1:0:4**
17. Contact Hours (L:T:P)	**3:2:0**
18. Prerequisites (if any)	**N.A.**
19. Course Basket	**E.S.**

20. Course Summary

A course in thermodynamics deals with the energy interactions and its effects on the properties of systems. Energy, equilibrium, and entropy are the key elements of this course.

21. Course Objectives

- To learn about different laws and principles of thermodynamics and their applications.
- To understand the concept of energy as low and high grade and its use in exergy analysis.
- To evaluate the changes in properties of pure substances in various processes.

22. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Apply energy balance to systems and control volumes, in situations involving heat and work interactions.
CO2: Evaluate changes in thermodynamic properties of pure substances.
CO3: Evaluate the performance of energy conversion devices.
CO4: Differentiate between high grade and low grade energies.

23. Curriculum Content

UNIT 1: Introduction to thermodynamics

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers

UNIT 2: First law of thermodynamics

Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy; Demonstration that energy is a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

UNIT 3: Pure substances

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

UNIT 4: Second law of thermodynamics and Entropy

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. Clausius inequality; Definition of entropy; Demonstration that entropy is a property; Evaluation of entropy for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of entropy from steam tables-Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles.

UNIT 5: Availability and Irreversibility

Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work, Exergy balance equation, and Exergy analysis.

Textbook(s)

1. Y.A., Cengel and M.A. Boles, "Thermodynamics: An Engineering Approach", McGraw Hill Education, 8th Edition.2017.
2. Nag, P.K, Engineering Thermodynamics, McGraw Hill Education, 6th Edition.2017.

Reference Books

1. Borgnakke, C. and Sonntag, R. E., Fundamentals of Thermodynamics, John Wiley& Sons, 10th edition 2019.
2. B. Jones and R.E. Duggan, Engineering Thermodynamics, Prentice-Hall of India,1st edition.1995.
3. M.J. Moran and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons, 7th edition.2010.

24. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF102**
3. Course Title	**Engineering Graphics**
4. Credits (L:T:P:C)	**2:0:4:4**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**N.A**
7. Course Basket	**ES**

8. Course Summary

This course enables the students to use engineering graphics skills as a means of recording and transmitting technical information and ideas from one mind to another. It communicates all needed information of things that are to be built or manufactured.

9. Course Objectives

- To learn the rules/ standards in writing titles, dimensions, notes and drawing particulars on drawing sheet with the help of drawing instruments.
- To learn the purpose and types of scales used in Engineering Drawing.
- To learn the methods of constructing various geometrical figures and their applications.
- To learn various methods of projections and improve the visualization skills before projecting two-dimensional views of any object.
- To study various shapes of solids and learn to create their sectional views.
- To learn about developing lateral surfaces of various solids.
- To develop skills in drawing three dimensional view of any object and understand the basic AutoCAD commands.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Acquire requisite knowledge, techniques and attitude of engineering drawing.
CO2: Able to read and interpret object drawings.
CO2: Able to visualize accurately and effectively for drawing orthographic/ isometric projections of any object.

11. Curriculum Content

UNIT 1: Introduction to Engineering Graphics

Introduction to drawing instruments, layout and sizes of drawing sheets and drawing boards, Title blocks, different types of lines used in engineering drawing as per BIS specifications, lettering (Alphabet and numerals) – upper case (Capital Letter), single stroke, vertical and inclined at 75 degrees, principles and methods of dimensioning, types of scale, definition of R.F., Drawing of plain and diagonal scales, Construction of regular polygons, circles and ellipses.

UNIT 2: Projections of Points and lines

Theory of orthographic projections, Projection of Points in different quadrants.
Projections of Straight Line– parallel to both the planes, parallel to one plane and perpendicular/ inclined to other. Line inclined to both HP and VP.

UNIT 3: Projections of Planes and Solids

Projections of different lamina (plane) like square, rectangular, triangular and circle parallel/ inclined to one plane and perpendicular to another plane.
Projections of solids in simple position - with axes inclined to one reference plane and parallel to other. Projections of solids with axes inclined to both the reference planes.

UNIT 4: Section of Solids and Development of Surfaces
Introduction to Sectioning, Sectioning of solid like cube, prism, pyramid, cylinder and cone, True shape of a section.
Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone. Development of the lateral surfaces of truncated solids.

UNIT 5: Isometric Projection and Auto CAD
Basics of isometric projections and isometric scale, Isometric views of simple solids – cube, prisms, pyramids, cylinder and cone. Conversion of Orthographic Views into isometric Views, Basic AutoCAD commands & their applications.

Textbook(s)

1. N. D. Bhatt and V.M. Panchal, "Engineering Drawing", Charotar Publishing House Pvt. Ltd., 53rd edition, 2016 reprint.
2. P.S. Gill, "Engineering graphics", S. K. Kataria& Sons, 13th edition, 2016.

Reference Books

1. Agarwal B. and Agarwal C.M, "Engineering Drawing", Tata McGraw Hill Publishing Co. Ltd., N. Delhi.
2. K. Venugopal and V. Prabhu Raja, "Engineering Graphics", New Age International Private Limited.
3. D.M. Kulkarni, A.P. Rastogi, A.K. Sarkar, "Engineering Graphics with AutoCAD", PHI Learning Pvt. Ltd.
4. G.S. Phull and H.S. Sandhu, "Engineering Graphics", Wiley Publications.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF103**
3. Course Title	**Engineering Mechanics**
4. Credits (L:T:P:C)	**2:1:2:4**
5. Contact Hours (L:T:P)	**2:2:4**
6. Prerequisites (if any)	**N.A**
7. Course Basket	**ES**

8. Course Summary

The course covers the basics concepts of engineering mechanics and increase the ability to solve problems involving forces, loads and moments and to know their applications in allied subjects.

9. Course Objectives

- To learn the basics of mechanics.
- To learn the force systems.
- To learn the analysis of trusses and beams.
- To study centroid of different sections.
- To learn the kinematics of body.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1. Identify principles of mechanics to be used for solving real life engineering problems.
CO2. Apply basic Engineering concepts based on force, shape and dimension for selection of material
CO3. Comprehend the action of Forces, Moments and other loads on systems of rigid bodies.
CO4. Compute the reactive forces and the effects that develop as a result of the external loads.
CO5. Express the relationship between the motions of bodies.

11. Curriculum Content

UNIT 1: Introduction to Engineering Mechanics

Basic idealizations - Particle, Continuum and Rigid body; Newton's laws of Force and its characteristics, types of forces-Gravity, Lateral and its distribution on surfaces, Classification of force systems, Principle of physical independence, superposition, transmissibility of forces, Introduction to SI units.

Couple, Moment of a couple Characteristics of couple, Moment of a force, Equivalent force - couple system; Numerical problems on moment of forces and couples, on equivalent force - couple system.

UNIT 2: Equilibrium of forces

Equilibrium of forces - Definition of Equilibrant; Conditions of static equilibrium for different force systems, Lami's theorem; Numerical problems on equilibrium of coplanar – concurrent and non-concurrent force systems

Application- Static Friction in rigid bodies in contact, Types of friction, Laws of static friction, Limiting friction, Angle of friction, angle of repose; Impending motion on horizontal and inclined planes; Numerical Problems on single and two blocks on inclined planes, ladder and wedge friction.

UNIT 3: Analysis of Plane truss and Beam

Support Reaction in beams: Types of beams, Types of Loads and Supports, statically determinate beams, Numerical problems on support reactions for statically determinate beams with Point load (Normal and inclined) and uniformly distributed and uniformly varying loads and Moments.

Plane Truss: Perfect and imperfect truss Assumptions and Analysis of Plane Truss by Method of joints and Method of section.

UNIT 4: Center of Gravity and Centroids
Introduction to the concept, Centroids of line and area, Centroids of basic geometrical figures, computing Centroids for– T, L, I, and full/quadrant circular sections.

UNIT 5: Kinetics of Particle
Newton's law of motion; Motion of bodies in Rectangular coordinates; D'Alembert's Principle.

Text book [TB]:

1. Engineering Mechanics by S.S. Bhavikatti, New Age International Publisher, New Delhi, 3rd edition 2009.
2. Engineering Mechanics-Statics and Dynamics by A Nielson, Tata McGraw Hill Education Private Ltd, New Delhi, 2009.

Reference Books [RB]:

1. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education 2010
2. Beer FP and Johnson ER, "Mechanics for Engineers- Dynamics and Statics"- 3rd SI Metric edition, Tata McGraw Hill. - 2008
3. Shames IH, "Engineering Mechanics – Statics & Dynamics"- PHI 2006

List of Experiments:

1. Study of different types of beam.
2. Calculation and Verification of forces in truss elements.
3. Calculation and verification of equilibrium condition on beam model.
4. Calculation to find the redundant force in a truss.
5. Mechanical advantage over pulley arrangement.
6. Determining the coefficient of friction.
7. Optional Tensile Strength
8. Optional Hardness Measurement

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF104**
3. Course Title	**Workshop Practices**
4. Credits (L:T:P:C)	**2:0:4:4**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**NA**
7. Course Basket	**ES**

8. Course Summary

Ability to prepare simple objects using machines and machine tools to make students aware of fundamental operations of manufacturing an engineering component, enhance visualization and motivate them to innovate.

9. Course Objectives

- To familiarize with the basic manufacturing processes and to study the various tools and equipment.
- They will get hands-on training is given in different sections. Essentially student should know the labour involved, machinery or equipment necessary.
- To analyze time required to fabricate and also should be able to estimate the cost of the product or job work.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Have Capability to identify hand tools and instruments for machining and other workshop practices.
CO2: Obtain basic skills in the trades of fitting, carpentry, welding and machining.
CO3: Acquire measuring skills, using standard workshop instruments & tools.
CO4: Gain eye hand co-ordination; enhance psycho motor skills and attitude.

11. Curriculum Content

UNIT 1: Machine Shop

To make a machined-component using lathe with mild steel round bar or hexagonal bar comprising of common turning operations with reference to drawing given in the manual.
Any one of the following jobs
Jobs: Hex Bolt, Axle for cycle wheel, Jig Bush, a typical turning specimen.

UNIT 2: Sheet metal Shop

To make a sheet metal component with galvanized iron sheet as per the drawing provided in the manual having spot welding joint.
Any one of the following jobs
Jobs: Square tray, Scoop, Funnel

Fitting Shop

To make a joint using fitting tools with mild steel flats, round bars or square bars as per the drawing provided in the manual.

UNIT 3: Welding Shop- Arc Welding

To prepare a welding joint with mild steel flat using Manual Metal Arc welding machine according to the drawing provided in the manual.
Any one of the following jobs
Jobs: Lap joint, Butt joint, Fillet/Corner joint

Gas & Spot Welding

To observe the demonstration of making a Lap joint/Butt joint with mild steel sheet using oxyacetylene flame as per the drawing provided in the manual. To perform the spot welding operation on G.I. Sheet.

UNIT 4: Carpentry Shop
To make a wooden joint with soft wood as per the drawing provided in the manual.
Any one of the following jobs
Jobs: T-Lap joint, Dove tail joint, Mortise & Tendon joint, Bridle joint.

UNIT 5: Foundry Shop
Introduction to foundry process like melting of metals, mould making, casting process and use of patterns to prepare of a component and significance of foundry.
Demo of mould preparation.

Minor Project:
To make a minor project by the students in batches comprising the operations performed in different shops

Textbook(s)

1. A course in Workshop Technology Vol I and Vol II by Prof. B.S. Raghuwanshi Dhanpat Rai & Co.(P) Ltd.
2. Elements of Workshop Technology Vol I and Vol II by S.K. Hajara Choudhury, A.K. Hajara Choudhury & Nirjhar Roy; Media Promoters & Publishers Pvt. Ltd, Mumbai

Reference Books

1. Workshop Technology Part 1 , Part2 & Part3 by W.A.J. Chapman; CBS Publishers & Distributors, New Delhi

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF201**
3. Course Title	**Mechanical Engineering Materials**
4. Credits (L:T:P:C)	**3:0:2:4**
5. Contact Hours (L:T:P)	**3:0:4**
6. Prerequisites (if any)	**NA**
7. Course Basket	**ES**

8. Course Summary

This course is intended to provide the students to the basic fundamental knowledge of engineering materials. This course also provides the study of crystal structures, mechanical properties and heat treatments of the engineering materials.

9. Course Objectives

The purpose of this course is to provide the students with solid foundations in the basic concepts of engineering materials. The main objective of the course is to study the fundamental principles underlying and connecting the structure, processing, properties, and performance of materials systems.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Able to define and identify a crystal structure and various structures of material.
CO2: Gain knowledge of mechanical properties of the materials.
CO3: Gain knowledge of phase diagram of alloys.
CO4: Learn about the heat treatment processes to enhance the mechanical properties of the materials.
CO5: Learn about the different materials like ceramics, plastics, composite etc.

Curriculum Content

UNIT 1:

Crystal Structures: Historical perspective, importance of materials, classification of materials, unit cell, space lattice, common crystal structures, atomic packing factors, Miller indices.
Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, Microscopic examination.

UNIT 2:

Mechanical properties of materials: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

UNIT 3:

Alloys, substitutional and interstitial solid solutions- Phase diagrams**:** Interpretation of binary phase diagrams and microstructure development; eutectic, paratactic, peritectoidand monotectic reactions.
Iron Iron-carbide phase diagram and micro-structural aspects of ledeburite, austenite, ferrite and cementite, cast iron. Time Temperature Transformation (TTT) diagrams.

UNIT 4:
Heat Treatment: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening.
Various types of carbon steels, alloy steels and cast irons, its properties and uses. Non-ferrous metals and alloys. Diffusion: Introduction, diffusion mechanisms, Steady-state diffusion, factors that influence diffusion.

UNIT 5:
Ceramics: Structure, types, properties and applications of ceramics. Rubber, Plastics: Various types of polymers/plastics and its applications. Mechanical behavior of plastics. Future of plastics. Other materials: Brief description of other material such as optical and thermal materials, concrete, Composite Materials and its uses. Brief introduction to Smart materials & Nano-materials and their potential applications.

Textbook(s)
1. W.D. Callister, Jr, -"Material Science & Engineering" Addition-Wesley Publication, 7th edition, 2007.
2. Er. R. K. Rajput, "Material Science,3rd edition, KATSON BOOKS.

Reference Books
1. Van Vlack, "Elements of Material Science & Engineering", 6th edition, John Wiley & Sons, 2010.
2. V. Raghvan "Material Science", 5th edition, Prentice Hall, 2005.

11. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF202**
3. Course Title	**Theory of Machines**
4. Credits (L:T:P:C)	**2:1:2:4**
5. Contact Hours (L:T:P)	**2:2:4**
6. Prerequisites (if any)	**Engg. Mechanics**
7. Course Basket	**DC**

8. Course Summary

In this course kinematic and dynamic behaviours of machine elements are studied in detail so that students can analyse the behaviour of the machine components while it is working. This course also helps to define the parameters of machine elements considering the geometry, the motion and the forces acting on the components.

9. Course Objectives

To learn about mechanisms, links and machines, motion of linked mechanisms in terms of displacement, velocity and acceleration of any point in a rigid link. To understand the kinematics of gear trains. To find the power transmission through gears, belts and pulleys, frictional torque in braking systems. To know the balancing of machines and gyroscopic effect in airplanes, four wheelers and ships.

10. Course Outcomes

After completion of the course, students will be able to:

CO1: To understand different mechanisms and the balancing of machines to reduce undesirable stresses in machine parts.

CO2: To know design of gears and pulleys for power transmission.

CO3: To reduce the vibrations and undesirable noise in machine parts.

CO4: Understanding the effect of gyroscopic couple in aeroplanes and ships.

11. Curriculum Content

Unit 1: Introduction to Mechanisms

Mechanisms and Machines : Link , kinematic pairs, degrees of freedom, kinematic chain, mobility of mechanism. Inversions of four bar chain and single slider crank chain.

Velocity and acceleration analysis of mechanisms (graphical method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism by vector polygons. Concept of coriolis component of acceleration.

Unit -2: Cams: Types of cams, types of followers, displacement curves for cam profiles, follower motions including SHM, uniform velocity.

Gears : Gear terminology, law of gearing, comparison of involute and cycloidal teeth. Simple gear trains, compound gear and epicyclic gear trains.

Unit -3: Static and Dynamic force Analysis: Static force analysis, free body diagram. Force analysis of four bar mechanism and slider-crank mechanism. Turning moment diagram, concepts and application of flywheel.

Belt drives: Flat belt drives, ratio of belt tensions. Power transmission, centrifugal effect, initial tension in belt drive.

Brakes: Types and their function, resisting torque calculation.

Unit-4 : Vibration: Free and forced vibration of single degree of freedom systems, effect of damping.

Balancing: Balancing of rotating masses in same plane and in different planes. Balancing of

reciprocating masses.

Unit- 5: Governor: Porter Governor, Hartnell Governors. Controlling force. stability, sensitiveness of governor

Gyroscope: Function of gyroscope, gyroscopic couple, effect of gyroscopic couple on ship and airplane.

List of Experiments

1. To study the different types of kinematic links, kinematic pairs and inversions of mechanisms.
2. To study different types of gears and gear trains.
3. To study different types of cams and followers.
4. To perform the experiments of static and dynamic balancing on a shaft.
5. To perform the experiment on a governor and to plot the graph between 'r' and 'f".
6. To perform the experiment on the Gyroscope & prove the law of gyroscope.
7. To perform an experiment on cam dynamics apparatus.
8. To calculate the frequency of a free vibrating spring.

Textbook(s)

1. S.S. Ratan, Theory of Machines, 4th edition, MGH, Education Publisher , 2009.
2. R.S. Khurmi and J K Gupta , Theory of Machines, S Chand publication, 2005.

Reference Books

1. Thomas Beven, Theory of Machines, 3rd edition, CBS Publishers and Distributors, 2005.
2. Robert L Norton Kinematics and Dynamaics of Machinery, Tata McGraw Hill, 2009.
3. Ghosh A and Mallick A.K ,Theory of Mechanism and Machines, East West Pvt. Ltd.

12. Teaching and Learning Strategy:

All materials (ppts of all units, assignments, labs manuals and concept notes etc.) will be uploaded in Moodle.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF203**
3. Course Title	**Applied Thermodynamics**
4. Credits (L:T:P:C)	**3:1:0:4**
5. Contact Hours (L:T:P)	**3:2:0**
6. Prerequisites (if any)	**Thermodynamics**
7. Course Basket	**DC**

8. Course Summary

This course is intended to expose the students to the applications of thermodynamics laws and principles to the fuels and combustion, gas and vapor cycles, air and steam flow through nozzles, steam turbines and reciprocating compressors.

9. Course Objectives

- To learn about first law application for fuels and combustion.
- To learn about gas and vapor cycles and their first law and second law efficiencies.
- To learn about gas dynamics of air flow and steam flow through nozzles.
- To learn about reciprocating compressors with and without intercooling.
- To analyze the performance of steam turbines.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of various practical power cycles and their performance estimation.
CO2: Analyze energy conversion in various thermal devices such as combustors, nozzles, diffusers, steam turbines and reciprocating compressors.

11. Curriculum Content

UNIT 1: Fuels and Combustion
Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables.

UNIT 2: Gas and Vapor power cycles
Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical Rankine cycle, Gas power cycles- Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles

UNIT 3: Flow through nozzles
Basics of compressible flow, Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam through nozzle, super saturation- compressible flow in diffusers, efficiency of nozzle and diffuser.

UNIT 4: Reciprocating Compressors
Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

UNIT 5: Steam turbines and Condensers
Analysis of steam turbines, velocity, and pressure compounding of steam turbines, steam condenser, condenser efficiency, and thermodynamic analysis.

Textbook(s)

3. Y.A., Cengel and M.A. Boles, "Thermodynamics: An Engineering Approach", McGraw Hill Education, 8th Edition.2017.
4. Rathore, M.M. "Thermal Engineering," McGraw Hill Education, 1st Edition. 2010.

Reference Books

2. Claus Borgnakke and Richard E. Sonntag, Fundamentals of Thermodynamics, Wiley, 7th edition.2009.
3. J.B. Jones and R.E. Duggan, Engineering Thermodynamics, Prentice-Hall of India,1st edition.1995.
4. M.J. Moran and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons, 7th edition.2010.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF204**
3. Course Title	**Machine Drawing And Solid Modeling**
4. Credits (L:T:P:C)	**2:0:4:4**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**Engineering Graphics**
7. Course Basket	**DC**

8. Course Summary

The objective of this course is to use engineering graphic skills as a means of communicating technical ideas, information, and instructions. Use of Sectional views, Part sectioning, Assembly drawings and Layouts forms a part of this learning. Student uses manual drafting and design software for this communication.

9. Course Objectives

- To learn about the basics of Machine drawing.
- To learn about the generation of drawings as a design process for machine assembly.
- To learn about use of datum planes to locate features and machine elements uniquely in assemblies.
- To learn about sectioning, dimensioning, notes and version control in drawings.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO 1. Understand part and assembly drawing concepts, engineering drawing and its classification.
CO 2. Representation of manufacturing symbols, materials etc.
CO 3. Be able to specify dimensions, and dimensional tolerances, surface finish etc.
CO4. Develop drafting and modeling skills using design software.

11. Curriculum Content

UNIT 1:
Introduction to Engineering Drawing, Classification of Engineering Drawings, Machine Drawing and representation of materials, Conventional representation of materials and common machine components. Representation of geometrical and dimensional tolerance and surface roughness symbols. Fundamental concepts of G and H, No-go and Go gauges.

UNIT 2:
Representation of welded joints. Projections, Sectional views and sectioning of parts and assemblies.

UNIT 3:
Engineering Graphics Software, Co-ordinate Systems, Drafting and Modelling, Evolution of geometric modeling, Advantages of solid modeling, Definition, Advantages and disadvantages of wireframe models, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).
Computer aided Drafting: Generation of points, lines, curves, polygons, dimensioning, utility commands etc.
Solid modeling: Use of modeling software, Part model, Assembly.

UNIT 4:
Drawing of Machine Elements and simple parts: Views of any three sets of the following machine elements and parts;

a) Popular forms of Screw threads, bolts, nuts, stud bolts.
b) Keys, cotter joints and knuckle joint.
c) Shaft coupling, spigot and socket pipe joint.
d) Journal, pivot and collar and foot step bearings.
e) Rivet joints for plates

UNIT 5:
Assembly Drawings: Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions; (any one)

a) Engine parts – connecting rod, piston assembly.
b) Other machine parts - Screws jacks, Machine Vices, Plummer block, Tailstock.
c) Valves: Steam stop valve, spring loaded safety valve, feed check valve and air cock

Textbook(s)

1. Bhatt.N.D. and Panchal.V.M. Machine Drawing, Charotar Publishing House Pvt. Ltd. Anand (Gujrat), 388001, 49thEdition, 2014.
2. Dhawan R.K, A Textbook of Machine Drawing, 2006 S. Chand Publication.
3. Narayana. K.L, Kannaiah P. & Reddy K. Venkata,Machine Drawing, New Age International (P) Ltd. Publishers, 4thEdition,2012.

Reference Books

1. Sidheswar. N, Kannaiah. P, & Sastry V.V.S.,Machine Drawing, 2010 McGraw-Hill Education (India) Private Limited, New Delhi-110016,2001
2. Pohit Goutam and Ghosh Goutam, Machine Drawing with AutoCAD, Pearson Education, Delhi, 2006.
3. John. K.C, A Textbook of Machine Drawing, PHI Learning, Delhi 2010.
4. Gill P.S, A Textbook of Machine Drawing, S. K. Kataria & Sons Publishers, New Delhi-110002, 18th Edition, 2013.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF205**
3. Course Title	**Fundamentals of IC engine and automobile**
4. Credits (L:T:P:C)	**3:0:2:4**
5. Contact Hours (L:T:P)	**3:0:4**
6. Prerequisites (if any)	**Thermodynamics**
7. Course Basket	**DC**

8. Course Summary

This course will help the students to get fundamental knowledge in working of major types of engines, and their different associative systems like lubricating, cooling, fuel systems, etc. Knowledge of this course will also be helpful to the students in knowledge of automobile engineering fundamentals.

9. Course Objectives

The purpose of this course is to provide the students with basic knowledge of I C engines and basics of automobile engineering. The main objective of the course is to teach how engines and its various subsystems work.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Students will be understand and conceive automobile engineering concepts.
CO2: Understand the prevalent technologies of mobility and internal combustion engines.
CO3: Understand the fundamental knowledge of various types of engines, and their different associative systems like lubricating, cooling, fuel systems.

11. Curriculum Content

Unit 1:
Introduction to I.C Engine, Engine types and their stuctural and operational details; classification; different thermodynamic cycles. Two stroke engines; four stroke engine; characteristics of engines; air capacity of engine; valve timing diagram; importance of volumetric efficiency. Characteristics of internal combustion engines, graphs and analysis.

Unit 2:
Engine Components, Material, construction and design aspects; piston assembly; connecting rod; crankshaft; cylinder head; cylinder block; flywheel, ports; valves; valve actuating mechanism; cams; camshaft drives. Multicylinder engines balancing concepts.

Unit 3: Fuel Supply in SI Engines: Carburetion and mixture requirements; Transfer pump; Carburetors – types, Mixture distribution and inlet manifold. The concept of multipoint fuel injection system, Fuel Supply in CI Engines; Injection system components; Jerk and Distributor pumps. CRDI system**.**

Unit 4:
Introduction to Automobiles their classification and types. Layout of an automobile chassis. Study of Automotive electrical system; basic transmission systems, cooling system, suspension system.

Unit- 5:
Steering system working, steering geometry, steering linkages, basic types of steering gear boxes, constructional details. Classification of brakes, drum brakes and disc brakes, constructional and working details, introduction to hydraulic brake, vacuum assisted Brakes, leading & trailing brake

shoes, Working of ABS.

Text book [TB]:

1. Automobile Engineering by Kripal sing vol. I, II.
2. Automotive mechanics by William course.

REFERENCES [RB]:

1. Automotive Technology by Sethi, TMH, New Delhi
2. Automobile Engineering by K.K. Ramalingam, Scitech Publication, Chennai – 2001

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF206**
3. Course Title	**Strength of Materials**
4. Credits (L:T:P:C)	**2:1:2:4**
5. Contact Hours (L:T:P)	**2:2:4**
6. Prerequisites (if any)	**Engg. Mechanics**
7. Course Basket	**D.C.**

8. Course Summary

This course is intended to understand the application of Strength of Materials in the analysis of stresses and designing of structures, columns beams and machine parts for safe load working conditions and good performance.

9. Course Objectives

- To learn about concept of simple stresses and strains.
- To learn about compound stress systems.
- To learn about the combined effect of axial, bending and torsional stresses on shafts.
- To learn about the defections in Beams and columns due to loading.
- To learn about the theories of Failure in any loaded system.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of calculating the stresses in machine parts.
CO2: Analyzing of safe design of machine or structural parts.

11. Curriculum Content

UNIT 1: Introduction to Stress & Strain : Introduction and definitions; Stress, Hooke's law; true and engineering stress-strain curves; axial stress; thermal stress and strain. Compound stresses, state of plane stress; stress on an inclined plane; Principal stresses and Principal planes; Mohr's stress circle.

UNIT 2: Properties of Sections : Centre of gravity and moment of inertia of commonly used cross sections as T, I, L cross sections of structural members
Stresses in Beams:
Shear force and bending moment diagrams; bending stresses in beams; shear stresses in beams.

UNIT 3: Torsion of circular shaft: Torsion equation; Power developed by shafts, series and parallel combinations in shafts.
Combined Stresses: Combined bending and torsion; Combined bending and axial thrust.
Strain energy: Concept and applications. In Torsion, bending and axial loadings

UNIT 4: Deflections of Beams: Introduction; differential equation of the deflected beam; Macaulay's method; Moment area method.
Column and strut: Euler's theory of buckling of column for different end conditions; limitations of Euler's formula; Rankine's formula.

UNIT 5: Thin cylinders & Shells: Hoop and axial stresses strain; volumetric strain.
Thick cylinders: Radial, axial and circumferential stresses in thick cylinders subjected to internal and external pressures.
Theories of failure: Application to two dimensional (plane stress) cases.

Textbook(s)

1. Sadhu Singh, "Strength of Materials"; 10th Edition, Khanna Publishers New Delhi.
2. Ramamrutham, S. and Narayanan, R., "Strength of Materials"; Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 17th Edition.

Reference Books

1. Stephen P. *Timoshenko.*, "Elements of Strength of Materials", 5th edition, East West, 2003.
2. Egor P. Popov, "Mechanics of Materials, 2nd edition, Pearson Education India, 2015.
3. James M. Gere, Stephen P. *Timoshenko.* "Mechanics of Materials, 2nd edition, CBS, 2006.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF207**
3. Course Title	**Manufacturing Processes**
4. Credits (L:T:P:C)	**3:0:2:4**
5. Contact Hours (L:T:P)	**3:0:4**
6. Prerequisites (if any)	**Workshop Practice**
7. Course Basket	**DC**

8. Course Summary

This course will give an introduction to concepts and technologies of the principal manufacturing processes utilized by industry – Primary, Secondary & Tertiary from a designer's viewpoint.

9. Course Objectives

- To learn about basics of manufacturing processes.
- To learn about Casting process and its associated terms.
- To learn about metal forming processes like rolling, forging, drawing, and extrusion.
- To learn about different welding processes.
- To analyze the mechanism of different non-traditional machining processes.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Define casting processes and suggest manufacturing sequence for simple product shapes
CO2: Guide on process sequence of sheet metal operations like Draw, Punch, Bend etc
CO3: Define type, material, and geometry of cutting tools.
CO4: Suggest different welding / joining process.
CO5: Discuss modern manufacturing processes like EDM, ECM, USM, LBM etc.

11. Curriculum Content

Unit 1: Conventional Manufacturing Process

Classification of Manufacturing Processes
Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Unit 2: Forming Process

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending).
Presses and their classification Compound vs. Progressive die, Forging equipment and methods: hand, drop and die forging.

Unit 3 Metal cutting:

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Unit-4 Joining/fastening processes:

Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Arc welding: Power sources and consumables. TIG & MIG processes and their parameters, Resistance welding-spot, seam projection friction welding etc. Defects in welds and their remedies, HAZ, Adhesive bonding, Powder Metallurgy- Introduction.

Unit- 5: Unconventional Machining Processes:
Study of Machining processes, Process parameters, and relations: EDM, ECM, LBM, EBM, PAM, Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining. Additive manufacturing: Rapid prototyping and Rapid tooling

List of Experiments
1) To perform experiment on punching, blanking and drawing operation on sheet metal.
2) Study of Composite Material.
3) To prepare a sheet metal product (square container).
4) Pipe bending Operation.
5) Experiment based upon rolling and extrusion operation.
6) Study of Jigs and fixtures.
7) To study and observe various stages of casting through demonstration of Sand Casting Process.
8) To make an S-hook from a given round rod, by following hand forging operation.
9) To make a Square rod from a given round rod, by following hand forging operation.
10) To prepare a sand mold, using the given single piece pattern.
11) To prepare a sand mold, using the given Split-piece pattern.
12) Compression strength test for moulding sand.
13) Permeability test
14) Sieve analysis to find grain fineness number of base sand.
15) To visit an industry for study and observation of Modern casting processes like investment casting, centrifugal casting, die casting, evaporative pattern casting.

TEXT BOOKS:
1. S. Kalpakjian and S. Schemid (2001), Manufacturing, Engineering and Technology, Addison Wesley.
2. A. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.

REFERENCE BOOKS:
1. MP Groover, “Fundamentals of Modern Manufacturig”, John Wiley & Sons 2002
2. PN Rao, “Manufacturing Technology”, Tata Mcgraw Hill, 2017.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF208**
3. Course Title	**Fluid mechanics and Machines**
4. Credits (L: T:P:C)	**2:1:2:4**
5. Contact Hours (L: T: P)	**2:2:4**
6. Prerequisites (if any)	**Engineering Mechanics**
7. Course Basket	**DC**

8. **Course Summary:** The course provides theoretical and practical knowledge of fluid mechanics and various fluid machines and their performance.

9. Course Objectives

- To understand the kinematic and dynamic behavior of fluid
- To understand the theory of boundary layer
- To learn about governing equations of fluid mechanics and machines
- To learn and understand the working and performance characteristics of various hydraulic machines.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO 1. Identify principles of fluid mechanics to be used for real life engineering problems.
CO 2. Understand the principle of floatation of objects in fluid.
CO 3. Understand the working of different pumps and their components.
CO 4. Know the working of different turbines and their components.
CO 5. Apply dimension analysis in formation of correlations.

11. Curriculum Content

UNIT 1: Introduction to Fluid Mechanics
Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension.
Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications, Archimedes principle, buoyancy.

UNIT 2: Laminar flow and boundary layer
Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli-Darcy Weisbach equation, friction factor, Moody's diagram, concept of boundary layer – measures of boundary layer thickness.

UNIT 3: Dimension analysis
Need for dimensional analysis – methods of dimension analysis, similitude, types of similitude Dimensionless parameters, application of dimensionless parameters, Model analysis.

UNIT 4: Hydraulic Pumps
Euler's equation – theory of rotodynamic machines, various efficiencies, velocity components at entry and exit of the rotor, velocity triangles.
Centrifugal pumps – working principle, work done by the impeller, performance curves, Cavitation in pumps.
Reciprocating pump – working principle.

UNIT 5: Hydraulic Turbines

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines –governing of turbines.

Textbook(s)

1. Bansal, R.K., "Fluid mechanics and hydraulic machines", Laxmi publications, 9th edition, New Delhi, 2014.

Reference Books

1. Yunus A. Çengel, "Fluid Mechanics", Tata McGraw-Hill Education, 2010.
2. Modi P.N and Seth S. M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.
3. Earl Logan, "Turbomachinery: Basic theory and applications", CRC Press, 2009.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1.	**Department offering the course**	**Mechanical Engineering**
2.	**Course Code**	**MEF301**
3.	**Course Title**	**Design of Machine Elements**
4.	**Credits (L:T:P:C)**	**3:1:0:4**
5.	**Contact Hours (L:T:P)**	**3:2:0**
6.	**Prerequisites (if any)**	**Theory of machines**
7.	**Course Basket**	**DC**

8. Course Summary

This course covers fundamental mechanical design topics, such as static and fatigue failure theories, the analysis of shafts, fasteners, gears etc. Students will examine a number of design case studies, reviewing critical material properties in design, such as stress, strength, and the coefficient of thermal expansion.

9. Course Objectives

This course provides an introduction to the students to have an overview of design methodologies employed for design of various machine components. Student will also learn to appreciate nature and applicability of empirical design principles, based on tests and safety considerations.

10. Course Outcomes

CO1:Develop fundamental understanding of Machine Design in an engineering perspective and know how to integrate it with other subjects in engineering practice.
CO2:Know how to analyze, evaluate and recommend materials on the basis of given problem statement.
CO3:Understand the influence of manufacturing processes in the design of machine element.
CO4:Understand safety, reliability concepts in static & dynamic Loading conditions.
CO5:Develop ability to analyze, M/c Elements, Gears, springs, Bolted & Riveted Joints, Bearings.

11. Curriculum Content

UNIT 1:

Introduction: Definition, Methods, standards in design & selection of preferred size. Limits, fits and tolerances. Introduction Stress Concentration, Fatigue loads and Failure BIS system of designation of steels. Design against static load: Modes of failure, Factor of safety, theories of failure, Simple & Compound stresses in machine elements. Fatigue failure, endurance limit, design for finite & infinite life, Soderberg & Goodman criteria, Modified Goodman criteria, S-N curve, Design of shafts under static and fatigue loadings.

UNIT 2:

Design of Joints: Welded joint, Riveted joints, threaded fasteners, Bolted/Screwed Joints. Pre-loaded bolts. Shaft, keys & coupling.

UNIT 3:

Mechanical springs: Design of Helical and leaf springs, Stress analysis in springs, Design against static & fatigue loading.

UNIT 4:
Design of transmission elements Basics of Spur Gear: Terminology, Classification, System of gear teeth, contact ratio, Interference, Backlash, Selection of gear materials, Design considerations. For gear pairs: spur, helical & bevel gears.

UNIT 5:
Analysis and design of sliding and rolling contact bearings systems, Sommerfeld Nos, Boyd Raimondi Charts Simple analysis and application of Power Screws.
CASE STUDY: Engineering Of Typ 800 /1000 cc Vehicle Clutch, Brake, Gear Box, and Differential systems.

Text Books

1. Shigley, J.E. and Mischke, C.R., "Mechanical Engineering Design", Fifth Edition, McGraw-Hill Intern; 2011.
2. V. B. Bhandari, "Design of Machine Elements", McGraw-Hill, Inc., 2005.

Reference Books

1. Sharma & Agarwal, "Design of Machine Elements", S.K. Kataria & Sons, 2013.
2. Sharma & Purohit, "Design of Machine Elements", Prentice-Hall of India, 2004.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF302**
3. Course Title	**Industrial Engineering**
4. Credits (L:T:P:C)	**3:1:0:4**
5. Contact Hours (L:T:P)	**3:2:0**
6. Prerequisites (if any)	**Manufacturing Processes**
7. Course Basket	**DC**

8. Course Summary

This course is intended to expose the students to the applications of Industrial Engineering principles to raise the productivity of organization and introduce to general management principles of Quality management, Operations management and Industrial Organization.

9. Course Objectives

This course introduces the students to have an overview of industrial engineering and management. Student will learn about production and its relation with productivity, selection of plant location and layout. Student will also learn about inspection, quality control and basics of managements

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Develop fundamental concepts of industrial engineering and management.
CO2: To familiarize the students with production, productivity and principles of work-study.
CO3: To enable the students understand the selection of plant location and layout.
CO4: To provide students an insight into the concepts of production planning and control.
CO5: To enable the students understand the inspection and statistical quality control.

11. Curriculum Content

UNIT 1: Production, Productivity and work study

Definition of production, Types of production systems, Definition of productivity, Application and advantages of productivity, Improvement tools, Reasons for increase and decreases in productivity. Introduction of work study, Importance and advantages of work study, Work study procedure.

UNIT 2: Location Selection and Plant Layout

Nature of location decision, Importance of plant location, Dynamic nature of plant location, Choice of site for selection, State regulations on location, Government policies on decentralization, Industrial estates, Economic survey of site selection. Principles of plant layout and its types, Factors affecting layout, Flow pattern and factors governing flow pattern, Travel chart, Analytical tools of plant layout.

UNIT 3: Production Planning and Control

Definition of production planning and control (P.P.C), Functions and objectives of P.P.C, Product design and development including standardization and simplification, Sales forecasting and its different techniques, Sequencing, Loading and scheduling, Techniques and their selection, Line of balance, Assembly line balancing, Dispatching, and Progress control.

UNIT 4: Inspection and Statistical Quality Control

Inspection– functions, Types, Objectives and benefits, Quality control– principles, Concepts of quality circles, Total quality management, Quality assurance, Quality audit, ISO, and Six sigma. SQC concept, Variable and attributes, Normal distribution curves and its property charts for variable and attributes and their applications and interpretation (analysis) process capability, Acceptance sampling, sampling plans, OC curves and AOQ curves.

UNIT 5: Basics of Management

Definition of management, Functions of management– Planning, Organizing, Staffing, Directing, Co-ordination, Controlling, Motivating, Communication, Decision making. Principles of management, Administration and management, Nature of management, Levels of management, Managerial skills, Managerial roles, Styles of management. Forms of organization– Line, Staff, Line-staff, Forms of ownership – Partnership, Joint stock, Cooperative society, Govt. sector etc.

Textbook(s)

1. Riggs, "Production System, Planning, Analysis and Control", Wiley, 3rd ed. 1991.
2. Mahajan, "Industrial Engineering and Production Management", Dhanpat Rai & Co., 2005.
3. Martand Telsang, "Industrial Engineering and Production Management", S Chand & company, 2nd ed.2006.

Reference Books

1. Banga and Sharma, "Industrial Engineering and Production Management", Khanna publishers.
2. Shankar, "Industrial Engineering and Management", Galgotia Publications Pvt. Ltd, 1st ed. 2000 (Reprint 2006).
3. Khanna, "Industrial Engineering and Management", Dhanpat Rai Publications, 17th edition 2010.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF303**
3. Course Title	**Heat Transfer**
4. Credits (L:T:P:C)	**2:1:2:4**
5. Contact Hours (L:T:P)	**2:2:4**
6. Prerequisites (if any)	**Thermodynamics**
7. Course Basket	**DC**

8. Course Summary

This course is designed to provide the detailed understating of heat transfer modes and their applications.

9. Course Objectives

- To formulate and solve one dimensional steady and unsteady heat conduction problems.
- To apply empirical correlations for natural and forced convection to different problems.
- To Study the basic principles of heat exchanger analysis and thermal design.
- To understand the principles of boiling and condensation
- To study the radiation heat transfer for black and gray bodies.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.

CO2: Analyze heat transfer through fins and unsteady state heat conduction problems.

CO3: Analyze convective heat transfer cases using exact, approximate, and empirical methods.

CO4: Design heat exchange devices and understand boiling and condensation heat transfer.

CO5: Analyze radiative heat exchange between black and gray surfaces.

11. Curriculum Content

UNIT 1: INTRODUCTION TO HEAT TRANSFER

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness.

UNIT 2: FINS & TRANSIENT CONDUCTION

Heat transfer through fins of uniform cross-section, lumped system approximation and Biot number-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

UNIT 3: CONVECTIVE HEAT TRANSFER

Heat convection, basic equations, boundary layers, Forced convection, external and internal flows, Natural convective heat transfer, Dimensionless parameters for forced and free convection heat transfer, Correlations for forced and free convection, Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

UNIT 4: BOILING, CONDENSATION &HEAT EXCHANGERS

Boiling and condensation heat transfer, pool boiling curve, types of heat exchangers, analysis and design of heat exchangers using both LMTD and ε-NTU methods.

UNIT 5: RADIATION HEAT TRANSFER

Basic radiation concepts, definitions of radiative properties, radiation laws, black and gray body radiation, shape factor, black-body radiation exchange, radiation exchange between non-blackbodies in an enclosure, Infinite parallel Planes, radiation shields.

Textbook(s)

1. Cengel, Y.A. and Ghajar, A.J. "Heat and Mass Transfer", Tata McGraw Hill Co.Ltd, 4th, edition, 2013.
2. Incropera, F.P., "Fundamentals of Heat & Mass Transfer", Wiley Publication, 6th edition, 2013.

Reference Books

1. Kreith, F. and Bohn, M.S., "Principles of Heat Transfer", Brooks/Cole, 6th edition, 2006.
2. Holman, J.P., "Heat Transfer", TataMcGraw-Hill Publishing Company Limited, 6th edition, 2008.
3. Thirumaleswar, M., "Fundamentals of Heat and Mass Transfer", Pearson Education, 1st edition, 2013.
4. Bejan, A., "Heat Transfer John Wiley", 1993.
5. Massoud K., "Principles of Heat Transfer", John Wiley, 2002.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF304**
3. Course Title	**Refrigeration and Air-conditioning**
4. Credits (L:T:P:C)	**2:1:2:4**
5. Contact Hours (L:T:P)	**2:2:4**
6. Prerequisites (if any)	**Thermodynamics**
7. Course Basket	**DC**

8. Course Summary

This course is designed to make the students familiar with the theory of refrigeration and air-conditioning and their applications. The analysis and design of refrigeration and air-conditioning systems will also be discussed.

9. Course Objectives

- To learn about air refrigeration systems.
- To learn about single stage vapour compression systems.
- To learn about multi-stage vapour compression systems and vapour absorption systems.
- To learn about psychrometry and its applications.
- To estimate the cooling load of air-conditioned space.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Apply thermodynamics and heat transfer concepts to analyze the refrigeration systems.
CO2: Understand the working and design aspects of refrigeration components.
CO3: Performance characteristics of different refrigerants.
CO4: Cooling load estimation and understanding of different air-conditioning processes.

11. Curriculum Content

UNIT 1: Introduction: Principles and methods of refrigeration; reverse Carnot cycle; unit of refrigeration; coefficient of performance (COP)
Air refrigeration system: Classification; Bell Coleman cycle; Open and closed air refrigeration cycles; Simple, Boot-strap, reduced ambient and regenerative cooling systems; Dry air rated temperature (D.A.R.T).

UNIT 2: Vapour compression system (single stage): Vapour compression cycle, p-h and t-s diagrams; deviations from theoretical cycle; Effects of sub-cooling and super heating, condenser and evaporator pressure on system performance.
Refrigerants: Nomenclature & classification; desirable properties; common refrigerants- comparative study; leak detection methods; Secondary refrigerants; Environment friendly & CFC free refrigerant.
UNIT 3: Vapour compression system (multi stage): Removal of flash gas; multiple expansion & compression with flash inter cooling.
Vapour absorption system: Theoretical and practical systems such as aqua-ammonia, Lithium bromide-water & Electrolux absorption systems.

UNIT 4: Psychrometry: Psychrometric properties and their definitions; psychrometric processes: sensible heating and cooling, evaporative cooling, cooling and dehumidification, adiabatic dehumidification, heating and humidification; adiabatic saturation temperature; mixing of air stream, sensible heat factor (SHF), apparatus dew point (ADP), bypass factor of coil; **Applied Psychrometry**: Air washer, cooling tower.

UNIT 5: Principle of air conditioning: Requirements of comfort air conditioning; thermal analysis of human body; human comfort, effective temperature & chart.
Air-conditioning loads: Basic knowledge of summer & winter air conditioning load; calculation of supply air rate & its condition; ventilation and infiltration, room sensible heat factor (RSHF), grand sensible heat factor (GSHF), effective sensible heat factor (ESHF).

Textbook(s)

1. Arora, C.P., "Refrigeration & Air-Conditioning," McGraw-Hill Education (India) Private Limited, 3rd Edition, 2008.

Reference Books

1. Colin R. Ferguson, Allan Thomson Kirkpatrick, "Internal combustion engines: Applied Thermosciences" John Wiley & Sons, 2nd edition, 2000.
2. Arora, S.C. and Domkundwar, S. "Refrigeration & Air-Conditioning," Dhanpat Rai & Co. (P) Ltd., 2013.
3. Roy J. Dossat. "Refrigeration & Air-Conditioning," Pearson Education India, 4th edition, 2002.
4. Stoecker, W., Jones, J., "Refrigeration & Air-Conditioning," McGraw-Hill Education, 2nd edition, 1983.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF305**
3. Course Title	**Measurement and Metrology**
4. Credits (L:T:P:C)	**3:0:2:4**
5. Contact Hours (L:T:P)	**3:0:4**
6. Prerequisites (if any)	**Physics**
7. Course Basket	**DC**

8. Course Summary

Engineering measurement and metrology is the use of measurement science in manufacturing. This course is designed to impart the knowledge to develop measurement procedures, conduct metrological experiments, and obtain and interpret the results. A laboratory demonstration are also induced to enhance the learning process

9. Course Objectives

- Understand the principle of operation and calibration of an instrument.
- Understand and calculate the least count of all basic measuring instruments.
- Select and use appropriate instrument/s for specific measurement.
- Understand the different devices used to measure force, torque, and pressure.
- Understanding the concepts of limits, fits and tolerance.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Know different measuring device for a particular application.
CO2: Explain various device and tools for angular measurements.
CO3: Know the various comparators with their working principles and applications.
CO4: Explain the different devices used to measure textures and surface finish.
CO5: Explain the different devices used to check the parallelism/ straightness of machine components.

Curriculum Content

UNIT 1: Introduction to measurements

Definition and Significance of measurement, Methods of measurements, Generalized measuring system, Standards of measurements, Factors in selecting the measuring instruments, Terms applicable to measuring instruments: Precision and Accuracy, Sensitivity and Repeatability, Range, Threshold, Hysteresis, calibration; Errors in Measurements: Classification of errors, Systematic and Random error.

UNIT 2: Measuring instruments

Introduction, working principle, method of reading, least count for Vernier Calipers, Micrometers, Thread measurements: Thread gauge micrometer, Angle measurements: Bevel protractor, Sine Bar, Gauges: plain plug gauge, ring Gauge, snap gauge, limit gauge, Comparators: Characteristics of comparators, Types of comparators, Surface finish -Definition, Terminology of surface finish.

UNIT 3: Measurement of force, torque, and pressure

Introduction, Force measurements: Spring Balance, Proving ring, Load cell; Torque measurement: Prony brake, Hydraulic dynamometer; Pressure measurement: McLeod gauge.

UNIT 4: Limits, Fits, Tolerances

Limit: Maximum limit, Minimum limit, Basic size, Nominal size, Fit: Types of fits-Hole basis and

Shaft basis system, Tolerance: Basic terminology, unilateral and bilateral tolerance, Interchangeability and selective assembly.

UNIT 5: Machine tool metrology
Testing instruments for machine tools, alignment testing, Checking Parallelism, Straightness: testing by straight edge, spirit level & Autocollimators, flatness testing by dial gauge, run out, alignment testing of machine tool as per IS standard procedure.

Textbook(s)

1. Sawhney A. K., "Mechanical Engineering Measurements"; Dhanpat Rai & Sons, New Delhi.
2. Bewoor Anand K., Kulkarni V., "Metrology & Measurement"; Tata McGraw hill New Delhi 2009.

Reference Books

1. "Engineering Metrology" by R.K.Jain, Khanna Publishers, New Delhi.
2. "Instrumentation measurement and analysis" by B.C.Nakara, K.K.chaudary; 2nd Edition, Tata McGraw hill.
3. Rajput R.K., Mechanical Measurement and Instrument, S.K. Kataria & Sons, New Delhi.
4. "Engineering Metrology & Measurements" by N V Raghavendra, L Krishnamurthy: Oxford Publication.
5. "Principles of Engineering metrology" by Rega Rajendra; Jaico publishers-2008
6. Engineering Metrology by K.J. Hume; Macdonald & Co. Ltd., London

11. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF306**
3. Course Title	**Computer Aided Design**
4. Credits (L:T:P:C)	**3:0:2:4**
5. Contact Hours (L:T:P)	**3:0:4**
6. Prerequisites (if any)	**Machine Drawing and Solid Modeling**
7. Course Basket	**DC**

8. Course Summary

The course is designed to teach basic concepts of CAD, modelling, and finite element methods.

9. Course Objectives

- To provide an overview of analytical treatment on of the use of computers in design.
- To understand the fundamental principles of hardware and software requirements in CAD.
- To design and draft simple and complex machine parts using CAD through wireframe and surface modelling.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Use computers in Product Design and Development Process.
CO2: Understand the prevalent display technologies.
CO3: Understand the modeling of CAD geometric elements.
CO4: Use CAD software for modeling mechanical components.
CO5: Design and conceive new concepts of the state of art.

11. Curriculum Content

Unit 1:

Fundamentals of CAD: Introduction, Reasons for implementing a CAD system, Computer Aided Process application, conventional design vs CAD.
Computer graphics: Graphics input devices-cursor control devices, digitizers, scanners and touch panels.
Graphics display devices: CRT, Color CRT monitors, DVST, Flat panel display, graphics output devices.

Unit 2:

Line Drawing algorithms: Bresenham's line drawing and Mid-Point Circle algorithms.
Geometric Modeling of Curves Types of mathematical representation of curves, wire frame models, wireframe entities, and parametric representation of synthetic curves- her mite cubic splines, Bezier curves, B-splines rational curves.

Unit 3:

Introduction to Geometric Modeling of Surfaces and Solids Surface entities utilized in CAD. Solid modeling, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).
Graphics Standards: PHIGS, IGES, PDES. Standards in CAD.

Unit 4:

Geometric transformations: Introduction, Transformation of Geometric Models, Translation, Scaling, Reflection, Rotation, Homogeneous Representation, Concatenated Transformation.

Unit- 5:

Finite Element Methods: Introduction and Application of FEM, Stiffness Matrix/ Displacement Matrix, One/Two-Dimensional bar & beam element (as spring system) analysis.

Text book [TB]:

1. Ibrahim Zeid, "Mastering CAD CAM", Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, "CAD/CAM Principles", II edition, Pearson Education, 1999.

REFERENCES [RB]:

1. W. M. Neumann and R.F. Sproul, "Principles of Computer Graphics", McGraw Hill, 1989.
2. D. Hearn and M.P Baker, "Computer Graphics", Prentice Hall Inc., 1992.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF341**
3. Course Title	**Automotive Transmission System**
4. Credits (L:T:P:C)	**2:1:0:3**
5. Contact Hours (L:T:P)	**2:1:0**
6. Prerequisites (if any)	**Fundamentals of I C engine and automobile**
7. Course Basket	

8. Course Summary

This course imparts basic knowledge to students with respect to current transmission system of automobiles and impart knowledge that will enable the student to analyse the layout of drive train and controlling mechanism of power transmission from the engine to the wheels.

9. Course Objectives

- To learn about different types of gear trains.
- To learn about fluid coupling & torque conversion.
- To learn about automatic transmission.
- To learn about drive line.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Determine various parts and types of gear box.

CO2: Understand phenomena of Hydrodynamics and Hydrostatic Drives.

CO3: Understand the various industrial terminology from transmission system.

11. Curriculum Content

UNIT 1: Gear Trains

Synthesis of simple, compound reverted gear trains, analysis of epicycle gear trains, problems. Necessity & function of gear boxes in Automobiles, method of calculation of gear ratios for vehicles, performance characteristics in different speeds, different types of gear boxes-sliding constant mesh, synchromesh, epi-cyclic and automatic, speed synchronizing devices, free-wheeling mechanism, overdrives, gear materials, lubrication. Planetary gearboxes, Ford T-model Wilson Gear box, determination of gear ratios, automatic overdrives.

UNIT 2: Fluid Coupling & Torque conversion

Fluid coupling advantages & limitations, constructional details, torque capacity, slip in fluid coupling, performance characteristics, measure to reduce drag in fluid coupling. Faults & remedies. Single, multi stage and poly-phase torque converters, performance characteristics.

UNIT 3: Automatic Transmission

Relative merits and demerits when compared to conventional transmission, automatic control of gears, study of typical automatic transmissions used in Indian vehicles, Ford & Chevrolet drive.

UNIT 4: Hydrostatic Drives

Advantages and disadvantages, principles of hydrostatic drive systems, construction and working of typical hydrostatic drives, Janney Hydrostatic drive.

Electrical drives: advantages and limitations, principles of Ward Leonard system of control

Modern electric drive for buses and performance characteristics.

UNIT 5: Drive line

Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft. Universal joints. Final drives – different types, double reaction final drive. Two speed rear axle. Rear axle construction – full floating, three quarter floating and semi-floating arrangements. Differential – conventional type, non-slip type. Differential locks.

Text books [TB]:

1. Motor Vehicle by Newton and Steeds, Illiffee Publisher - 2000
2. Modern Transmission system by Judge AW, Chapman & Hall 2006

Reference Books [RB]:

1. Passenger Car Automotive Transmissions by Design Practices, SAE Hand book – 1994.
2. Torque converters by Heldt P.M., Chilton Book Co.-1992
3. Automotive Transmission and power trains constructions by Crouse WH, Anglin DL, McGrawHill

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF342**
3. Course Title	**Vehicle Maintenance**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:2**
6. Prerequisites (if any)	**Fundamentals of IC engine and automobile**
7. Course Basket	**DE**

8. Course Summary

To make the student understand the need for vehicle maintenance and its importance and to familiarize the maintenance aspects of an automobile**.**

9. Course Objectives

- To learn about the basic features of vehicle maintenance.
- To learn the methods and process of maintaining different systems of an automobile.
- To acquire hands on knowledge by performing some maintenance practical.
- To learn the maintenance record keeping and knowledge of tools and techniques.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Inspect and diagnose the problems occurring in the various components of the vehicle.
CO2: Acquire knowledge about basic maintenance principle of vehicle.
CO3: Understand failure of vehicular components and prevention
CO4: Know preventive and predictive techniques for vehicular maintenance.

11. Curriculum Content

UNIT 1:

Need for maintenance, types of maintenance: preventive and breakdown maintenance, requirements of maintenance, preparation of check lists. Inspection schedule, maintenance of records, log sheets and other forms, safety precautions in maintenance: General safety, tool safety.

UNIT 2:

Figs and Specifications of standard tools; non Standard tools; denting tools; painting equipment; testing equipment; Service station equipment; Hydraulic lift; Tyre changer; Tyre inflation gauge; Car Washer; Air Compressor; Spark Plug Cleaner and Tester; brake and transmission bleeding equipment; Grease Guns;
Hydraulic Hoist; Analyzers: CO; HC; NOx; smoke meter: Engine analyzer: Petrol and Diesel; Ignition timing light; Wheel Balancer; Wheel aligner; Headlight aligner; Cylinder boring and honing; crankshaft grinder; Brake lathe m/c; ridge cutter and boring m/c; Trolley Jacks; Engine lifting cranes

UNIT 3:

Procedure for carburetor based S.I Engine tuning; use of compression gauge; vacuum gauge; engine analyzer; exhaust analyzer; battery tester S.G tester; adjustment of spark plugs electrodes; Cam-dwell angle; valve tappet clearance; CB point; carburetor cleaning; air filter cleaning; replacement of engine oil and filter; ignition timing setting by timing light; tightening head bolts. Tyre inflation pressure; checking fuel consumption; MPFI and CRDI Engines: Study of tools needed to service the system: assembly line diagnostic link (ALDL) connector; ALDL read out scan tool; test light; ohmmeter; digital volt meter; jumper wires; vacuum gauge; Tachometer; computerized automotive maintenance system. Knowledge of diagnostic codes; service engine soon (SES) light; ECM; CALPAK. Study of

important components : name; location and functions : TPS; IAC valve; ECM; MAP sensor; engine coolant temp sensor; IAT sensor; VSS; camshaft and Crankshaft – position sensor; start signal; PSP switch; Oxygen sensor; Fuel Vapor Canister; Catalytic Converter; Particulate filter; Troubles and diagnosis MPFI engines.

UNIT 4:

Tools used for engine disassembly, dismantling of engine components: cylinder head, valve train, cylinder block, connecting rod, piston and crankshaft assembly; cleaning and inspection of engine components, reconditioning of components. Cooling system: water pump, radiator, thermostat. Lubrication system maintenance, Anticorrosion and anti-freeze additives.

UNIT 5:

Servicing and maintenance of clutch, gear box, universal joints, propeller shaft, differential system. Service and maintenance of brake – disc and drum brakes, steering wheel and suspension systems, wheel alignment, vehicle body maintenance.

List of Experiments

1. Study of Automobile Repair Shop with the help of Layout.
2. Study and Preparation of Workshop Statements.
3. Experimental Study about Tools and instruments used in the maintenance shop.
4. Experiment to perform tuning of automobile multi cylinder engine.
5. Study and diagnosis of ignition, starting and charging system.
6. Study and diagnosis of Automobile fuel systems, filters & air cleaners
7. Wheel Balancing and adjustment of head light
8. Adjustment of pedal play in clutch brake, hand brake and steering wheel and Braking system troubleshooting.

Textbook(s)

1. Shrivastava, Sushil Kumar., "Industrial Maintenance Management", S Chand & Company Ltd., 2005
2. Knott and Phil Knott, "An Introductory Guide to Motor Vehicle Maintenance: Light Vehicles", EMS publishing, 2010

Reference Books

1. Kholi.P.L. "Automotive Chassis and Body", Tata McGraw-Hill Co., Ltd.,New Delhi, 1975.
2. Tim Giles, "Automotive service: Inspection, maintenance and repair", 3rd edition, 2007
3. Service manuals of various OEMs

3. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF343**
3. Course Title	**Design of Transmission System**
4. Credits (L:T:P:C)	**2:1:0:3**
5. Contact Hours (L:T:P)	**2:1:0**
6. Prerequisites (if any)	**Design of Machine Elements**
7. Course Basket	**DE**

8. Course Summary

To learn about the design procedures for mechanical power transmission components.

9. Course Objectives

- To learn about some transmission systems i.e. belt drives & chain drives.
- To learn about different gears i.e. Spur, helical, bevel & worm.
- To learn about design of gear box.
- To learn about clutch & brake systems.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Design transmission systems for engines and machines.

CO2: Students will learn about gear box design and selection process.

CO3: students will able to design cam design and selection process of any application.

11. Curriculum Content

UNIT 1:

Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets

UNIT 2:

Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.

UNIT 3:

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears.

UNIT 4:

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine tool applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications.

UNIT 5:

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake.

Textbook(s)

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Yi Zhang, Chris Mi, Automotive Power Transmission Systems, John Wiley & Sons, 31-Aug-2018

Reference Books

1. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
2. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF344**
3. Course Title	**Automotive Electrical & Electronics**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:2**
6. Prerequisites (if any)	**Basic electrical & electronics**
7. Course Basket	**DE**

8. Course Summary

This course provides an understanding of application of electrical and electronic system in automobile vehicle.

9. Course Objectives

Understanding, use, handling of electrical and electronic system in automobile vehicle.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the follo CO1: Understand the basic auto electrical systems.

CO2: Understand the layout of wiring and connections of electrical systems in automobiles.

CO3: Understand the working of different electrical components used in automobiles.

11. Curriculum Content

UNIT 1: Batteries and Accessories

Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Lighting system: insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods – Horn, wiper system.

UNIT 2: Starting and Charging System

Starting System: Condition at starting, behaviour of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, Starter motor requirements, care and maintenances of starter motor, Drive mechanisms, starter switches.

Charging System: Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cut out. Voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects and bridge rectifiers, new developments

UNIT 3: Fundamentals of Automotive Electronics

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, on board diagnostic system, security and warning system.

UNIT 4:

Types of sensors: sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

UNIT 5: Safety and Security Systems

Keyless entry system, Antilock braking system, Air bag restraint system, Adaptive cruise control system, Voice warning system, Seat belt system, antitheft system.

Textbook(s)

1. Bechhold "Understanding Automotive Electronics", SAE, 1998.
2. Kholi.P.L. "Automotive Electrical Equipment", Tata McGraw-Hill Co., Ltd., New Delhi, 1975.

Reference Books

1. Crouse, W.H. "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, 1986.
2. Robert Bosch "Automotive Hand Book", SAE (5th Edition), 2000.

11.Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF345**
3. Course Title	**Vehicle Body Engineering**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Fundamentals of I C engine and automobile**
7. Course Basket	**DE**

8. Course Summary

Course provides the basic knowledge about construction techniques & various types of automotive bodies under the light of aerodynamics.

9. Course Objectives

- To provide the basic knowledge about construction techniques in vehicles.
  To learn about various types of automotive bodies under the light of aerodynamics.
- To learn the body construction of heavy vehicles.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Be exposed the fundamentals in various automotive body construction techniques.

CO2: Integrate the concepts of aerodynamics in body engineering for better style and low drag.

CO3: Familiarizes the various types of bus body construction, seating layout, regulations and comfort.

11. Curriculum Content

UNIT 1:

Car Body Details: Types: Saloon, Convertibles, Limousine, Estate van, racing and sports car. Visibility: Regulations, driver's visibility, test for visibility, Methods of improving visibility and space in cars. Safety: Safety design, safety equipment for car. Car body construction.

UNIT 2:

Vehicle Aerodynamics: Objectives, Vehicle drag and types, various types of forces and moments, Effects of forces and moments, side wind effects on forces and moments, various body optimization techniques for minimum drag. Wind tunnel testing: Flow visualization techniques, scale model testing. Component balance
to measure force sand moments..

UNIT 3:

Bus Body Details: Types, minibus, single decker, double decker, two level, split level and articulated bus. Bus Body Lay Out: Floor height, engine location, entrance and exit location, seating dimensions.

UNIT 4:

Constructional details: Frame construction, Double skin construction-Types of metal section used-Regulations-Conventional and Integral type construction.

UNIT 5:

Commercial Vehicle Details: Types of body, Flat platform, drop side, fixed side, tipper body, tanker body. Light commercial vehicle body types, Dimensions of driver's seating relation to controls, driver's cabin design. Body Materials, Trim and Mechanisms: Steel sheet, timber, plastics, GRP,

properties of materials-Corrosion anti-corrosion methods, scalation of paint and painting process, body trim items.

Textbook(s)

1. Powloski. J. Vehicle Body Engineering, Business Books Ltd.1989.
2. Giles. J. C. Body construction and design, IIIiffe Books Butterworth& Co.,1971
3. John Fenton, Vehicle Body layout and analysis, Mechanical Eng. Publication Ltd., London,1982
4. Handbook of Automotive Body Construction and Design Analysis John Fenton .ISBN: 9788126548163 464, distributed by Mehul Book Sales.

Reference Books

1. Braithwaite. J. B, Vehicle Body building and drawing, Heinemann Educational Books Ltd.,London,1977.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF346**
3. Course Title	**Artificial Intelligence for Mechanical Engineering**
4. Credits (L: T: P:C)	**3:0:0:3**
5. Contact Hours (L: T: P)	**3:0:0**
6. Prerequisites (if any)	**Problem Solving and Prog.**
7. Course Basket	**DE**

8. Course Summary

This course is intended to expose the students to the applications of Computers and principles of the artificial intelligence and application of various techniques of the same

9. Course Objectives

CO1: Appreciate the importance of Artificial intelligence in the product development.
CO2: Understand the prevalent reasoning methods.
CO3: Understand the various search techniques.
CO4: Can understand the application of agents
CO5: Students will be able to design and conceive new concepts of the state of art

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of various aspects of artificial intelligence.
CO2: Analyze usage and application of the AI in Mechanical Engineering.

11. Curriculum Content

UNIT 1:

Artificial Intelligence – Definition(s), Approaches to AI, Generic Techniques & Representation, State space representation of problems, Agent, Search Space or State Space State, Problem Definition/Specification, Simulation of Sophisticated & Intelligent Behavior Source System Experimental Frame Model Simulator Intelligent Agents in Simulation, Distributed Artificial Intelligence and Simulation Agent Simulation Architectures

UNIT 2:

Expert System, Expert System Technology, Expert System Shell, Development of Expert Systems, Components and Capabilities of Expert System, Capability of Reasoning & explanation, Capability of Knowledge acquisition and update, Architecture of ES, Factual Knowledge, Heuristic Knowledge, Priori Knowledge, Posteriori Knowledge, Self-Explaining System, Benefits of Expert Systems, Applications of Expert System, Weber's Law, Machine vision, Machine hearing, Machine touch, Speech Recognition, Use of Ai For Speech Recognition, Limitations of Speech Recognition

UNIT 3:

Search Strategies, Informed / Heuristic Search Strategies, Best First Search, Hill Climbing Search , Mean Ends Analysis, Generate-and-test, Constraint satisfaction, Blind or Exhaustive or Uninformed Search Strategies, Breadth-First Search, Depth-First Search, Depth-First Iterative Deepening, Depth-Limited Search, Differences Between Depth First and Breadth First Game Playing / Adversarial Search Problems Terminology, Minimax algorithm, Pruning,
Alpha Beta Pruning .

UNIT 4:
Reasoning, Default Reasoning, Non-monotonic Reasoning, Approaches to Handle Uncertainty to Take Rational Decisions, Utility Theory, Probability and Bayes theorem, EVENTS, Union of Events, Intersection of Events, Disjoint Events, Independent, Dependent & Exclusive Events, Probability of independent events, Probability of dependent events, Mutually exclusive and Exhaustive events.

UNIT 5:
Knowledge & Knowledge Representation, Need of Knowledge Representation, Types of knowledge, Procedural knowledge, Declarative knowledge, Heuristic knowledge, Meta – Knowledge, Structural Knowledge, Commonsense Knowledge, Ontological Knowledge, Relational Knowledge, Inheritable Knowledge, Inferential Knowledge, Difference between Procedural and Declarative knowledge, Key Aspects of Knowledge Representations: Components of a Good Representation, Properties of Good Knowledge Representation, Adequacy, Efficiency, Computable & Structured, Concise and Transparent

Textbook(s)

1. Winston, Patrick Henry. Artificial Intelligence. 3rd ed. Addison-Wesley, 1992.

Reference Books

5. Yip, Kenneth, and Gerald Jay Sussman. This resource may not render correctly in a screen reader."Sparse Representations for Fast, One-Shot Learning."
6. The Boosting Approach to Machine Learning: An Overview." MSRI Workshop on Nonlinear Estimation.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF347**
3. Course Title	**Fundamental of Robot Vision**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Problem Solving and Prog.**
7. Course Basket	**DE**

8. **Course Summary:** To learn about various components of vision systems and its usefulness for Robot navigation and guidance.

9. **Course Objectives**

- Extracting, characterizing and interpreting the information from sites/default/files
- To learn basic preprocessing techniques of image processing.
- To learn basic about the object recognition techniques.
- To determine the hold site and gripper orientation based on collision fronts is described
- Review of existing vision systems and a case study for Navigation is discussed

10. **Course Outcomes:** On successful completion of the course, students will be able to achieve the following:
CO1: Extracting, characterizing and interpreting the information from sites, or images.
CO2: Basic preprocessing techniques of image processing.
CO3: Object recognition techniques
CO4: To determine the hold site and gripper orientation based on collision fronts is described
CO5: Review of existing vision systems and a case study for Navigation is discussed

11. **Curriculum Content**

UNIT 1: ELEMENTS OF IMAGE PROCESSING: Introduction, Discretization, pre-processing, Neighbourhood averaging, Median filtering. Smoothening of binary / sites / default /files. Thresholding, Edge detection.

UNIT 2: IMAGING COMPONENTS: Point sensor, line sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, and picture coding techniques.

UNIT 3: OBJECT RECOGNITION BY METHOD OF MOMENTS: Introduction, Feature set, Recognition procedure, Mahalanobic procedure, Template - matching, structural techniques.

UNIT 4: COLLISON FRONTS ALGORITHM: Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

UNIT 5: NEED FOR VISION TRAINING AND ADAPTATIONS: Review of existing systems - Binary, Gray level, structure of light, character recognition system, examples. Automatic part Recognition by SRI vision system - Automated Navigation guidance by vision system - A case study

Textbook(s)

1. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995

Reference Books

1. Richard D. Klafter, Thomas. A Chmielewski, Michael Negin, Robotics Engineering an Integrated Approach, Prentice Hall of India Pvt. Ltd., 1989
2. Mikell P. Groover, Mitchell weiss, Roger N. Nagel, Nicholas G.Odrey, Industrial Robotics, Technology programming and Applications, 1986
3. John J. Craig, Introduction to Robotics Mechanics and Control, Second Edition, Addison Wesly Longman Inc. International Student edition, 1999
4. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robtics and Automation Sensor - Based integration, Academic Press, 1999
5. S.R. Deb, Robotics Technology and flexible automation, Tata Mc Graw Hill Publishing company Ltd., 1994
6. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, Mc Graw Hill Book Company, 1987

13. Teaching and Learning Strategy

PPT, Assignment, Programming.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF348**
3. Course Title	**Robotics Engineering**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Theory of machines**
7. Course Basket	**DE**

8. Course Summary

Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem including operations, performance, test, manufacturing, cost, and schedule. This subject emphasizes the links of systems engineering to fundamentals of decision theory, statistics, and optimization. It also introduces the most current, commercially successful techniques for systems engineering.

9. Course Objectives

CO1: Identify a Robot for a specific application.
CO2: To develop student's skills in understanding sensor and allied devices.
CO3: Apply and understand the safety issues during the handling of robots.
CO4: Understand and Apply robotic programing
CO5: Appreciate the usage and application of robots in various domains.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of various aspects of Robotics
CO2: Analyze usage and application of the Robotics Engineering in the actual environment.

11. Curriculum Content

UNIT 1:

Basic concepts of robotics (Laws of robotics, robotic systems), RIA definition. History of Robotics, Automation and robotics, Robot anatomy (Robot configurations, Robot motions, Joint notation scheme), Robot Manipulators kinematics, Kinematics: Forward and inverse kinematics, Problems on kinematics, Precision movement (Spatial resolution, accuracy, repeatability)
Work volume, robot specifications, Types of Robot drives, electric drive, Hydraulic, pneumatic drives, Basic robot motions, Point to point control, continuous path control. Robot control - unit control system concept. Servo and non-servo control of robot joints. Adaptive and optimal control.

UNIT 2:

End effectors-Introduction, classification, Mechanical, Magnetic grippers, Vacuum and adhesive gripper, Gripper force analysis and design, Problems on gripper design and force calculation, Sensor devices, Types of sensors - contact, position and displacement sensors, Force and torque sensors, Proximity and range sensors, acoustic sensors. Robot vision systems - Sensing and digitizing, Image processing and analysis.

UNIT 3:

Robot work cell design and control, Safety in robotics, Robot cell layouts – multiple, Multiple robots and machine interface, Robot cycle time analysis

UNIT 4:
Robot language, classification, Programming methods - off and on-line programming, Lead through method-powered and Manual lead through, teach pendent method, VAL systems and language, Simple program, Palletizing program, Welding robot program, Program on Loading/Unloading of press.

UNIT 5:
Application of Robots with examples.
Material handling, Constrains, Application - Machine loading and unloading.
Assembly Robot, Assembly operation, RCC device, Benefits Inspection robot, used in Quality control. Welding Robot, features, sensors, Advantages, -Painting Robot, Requirement, and Spray painting, Mobile robot, mobility and application.
Microbots, types and Application, Recent developments in robotics- safety considerations..

Textbook(s)

1. Klafter.R.D, Chmielewski.T.A and Noggins, "Robot Engineering: An Integrated Approach", Prentice Hal of India Pvt. Ltd., New Delhi, 2010.

Reference Book(s)

1. Fu K.S, Gonzalez, R.C., Lee, C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book Co., Singapore, Digitized 2007.
2. Craig.J.J, "Introduction to Robotics mechanics and control", Addison- Wesley, London, 2008.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF349**
3. Course Title	**Robotics kinematics & dynamics**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Theory of machines**
7. Course Basket	**DE**

8. Course Summary

Robotics holds the study of those machines that can replace human beings in the execution of tasks, as regards both physical activity and decision making. In all robot applications, the realization of a task requires the execution of a specific motion prescribed to the robot. The correct execution of such motion is entrusted to the control system which should provide the robot's actuators with the commands consistent with the desired motion. Motion control demands an accurate analysis of the characteristics of the mechanical structure, actuators, and sensors. The goal of such analysis is the derivation of the mathematical (kinematic and dynamic) models describing the input/output relationship characterizing the robot components. Modelling a robot manipulator is therefore a necessary premise to develop motion control strategies.

9. Course Objectives

- The objective of the course is to introduce the methodological bases of the robots modeling and control, as well as the main theoretical and practical aspects of these topics.
- To reach this objective, the course presents the key ideas on robots' morphology, kinematics and dynamics, passing later to analyse the control of movements and force.
- The course contents are completed with the study of the control guided by vision concluding with practical aspects of the robot control systems architecture and programing.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of various types of robots and its parts.
CO2: Analyze and perform various kinds of motions performed by robots.

UNIT 1: Introduction to Robots

Historical Development, Robot Components-Link,Joint,Manipulator,wrist,Endeffector, Actuators, Sensors, Controller. Robot Classifications- Geometry, Workspace, Actuation Control, Application.
Introduction to Robot's Kinematics, Dynamics and Control-Triad, Unit Vectors, Reference Frame and Coordinate System, Vector Function, Problems of Robot Dynamics.
Preview of Covered Topics Robots as Multi-disciplinary Machines.

UNIT 2: Kinematics

Rotation Kinematics

Rotation About Global Cartesian Axes, Successive Rotation About Global Cartesian Axes,Global Roll-Pitch-Yaw Angles, Rotation About Local Cartesian Axes, Successive Rotation About Local Cartesian Axes, Euler Angles, Local Roll-Pitch-Yaw Angles, Local Axes Versus Global Axes Rotation, General Transformation, Active and Passive Transformation

UNIT 3: Orientation kinematics

Axis-angle Rotation
Euler Parameters, Determination of Euler Parameters, Quaternions, Spinors and Rotators, Problems in Representing Rotations-Rotation matrix, Angle-axis, Euler angles, Quaternion, Euler parameters.

Composition and Decomposition of Rotation.

Motion Kinematics
Rigid Body Motion, Homogeneous Transformation, Inverse Homogeneous Transformation
Compound Homogeneous Transformation-Screw Coordinates, Inverse Screw, Compound Screw Transformation, The Plucker Line Coordinate, The Geometry of Plane and Line (Moment, Angle and Distance, Plane and Line) screw and Plucker Coordinate

UNIT 4: Forward Kinematics

Denavit-Hartenberg Notation, Transformation between Two Adjacent Coordinate Frames, Forward Position Kinematics of Robots, Spherical Wrist Assembling Kinematics-Coordinate Transformation Using Screws, on Denavit-Hartenberg Methods.

Inverse Kinematics
Decoupling Technique, Inverse Transformation Technique-Iterative Technique, Comparison of the Inverse Kinematics Techniques (Existence and Uniqueness of Solution, Inverse Kinematics Techniques), Singular Configuration.

Angular Velocity
Angular Velocity Vector and Matrix (Time Derivative and Coordinate Frames) Rigid Body Velocity (Velocity Transformation Matrix), Derivative of a Homogeneous Transformation Matrix

UNIT 5: Dynamics
Acceleration Kinematics Angular Acceleration Vector and Matrix, Rigid Body Acceleration (Acceleration Transformation Matrix) ,Forward Acceleration Kinematics
Inverse Acceleration Kinematics (Rigid Link Recursive Acceleration).

Motion Dynamics Force and Moment**,** Rigid Body Translational Kinetics, Rigid Body Rotational Kinetics, Mass Moment of Inertia Matrix, Lagrange's Form of Newton's Equations, Lagrangian Mechanics.
Robot Dynamics Rigid Link Newton-Euler Dynamics (Recursive Newton-Euler Dynamics), Robot Lagrange Dynamics (Lagrange Equations and Link Transformation Matrices), Robot Statics

Textbook(s)

1. Prof. Reza N. Jazar, "Theory of Applied Robotics", SPRINGER, 2nd Edition.2010.

Reference Books

1. Saha, S.K., "introduction to robotics, 2nd edition, McGraw-Hill higher education, new Delhi, 2014.
2. Niku Saeed B., "introduction to robotics: analysis, systems, applications", PHI, New Delhi.
3. Mittal R.K. and Nagrath I.J., "Robotics and control", Tata McGraw hill.
4. Mukherjee s., "robotics and automation", Khanna publishing house, Delhi.
5. Craig, J.J., "introduction to robotics: mechanics and control", Pearson, New Delhi, 2009.

6. **Teaching and Learning Strategy**
   All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF350**
3. Course Title	**Heat exchangers: Fundamentals and Design Analysis**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**N.A.**
7. Course Basket	**DE**

8. Course Summary

The course is designed to expose the students to the fundamentals and design methods of different types of heat exchangers.

9. Course Objectives

To impart knowledge of various types of heat exchangers, their construction, design and performance behavior.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following

CO1: Understand the basic design methods for sizing and rating heat exchangers.
CO2: Understand able to apply single phase forced convection correlations in designing of heat exchangers.
CO3: Understand able to apply concept of pumping power and fouling factor in designing of heat exchangers
CO4: Understand and able to design double pipe and shell & tube heat exchangers.
CO5: Able to design phase change and compact heat exchangers and also understand its performance evaluation.

11. Curriculum Content

Unit 1: Basic Design Methods of Heat Exchangers

Introduction, Arrangement of Flow Path in Heat Exchangers, Basic Equations in Design, Overall Heat Transfer Coefficient, LMTD Method for Heat Exchanger Analysis, Parallel and Counter Flow Heat Exchanges, Multipass and Cross Flow Heat Exchangers, The ε-NTU Method for Heat Exchanger Analysis, Heat Exchangers Design Calculations and Methodology.

Unit 2: Forced Convection Correlations for the Single Phase Heat Exchangers

Hydrodynamically Developed and Thermally Developing Laminar Flow in Smooth Ducts, Annular, Turbulent Forced Convection, Turbulent Flow in Smooth Ducts, Heat Transfer from Smooth-Tube Bundles, Heat Transfer in Helical Coils and Spirals, Nusselt Numbers of Helical and Spiral Coils, Heat Transfer in 90° and 180° Bends.

Unit 3: Pressure Drop and Fouling Factor in Heat Exchanger

Tube-Side Pressure Drop in Circular and non-circular Cross Sectional Tubes, Pressure Drop in Tube Bundles in Cross flow, Pressure Drop in Helical and Spiral Coils, Heat Transfer and Pumping Power Relationship.
Effect of Fouling on Heat Transfer, Effect of Fouling on Pressure Drop, Categories of fouling, Design of Heat Exchangers Subject to Fouling, Fouling Resistance, Cleanliness Factor.

Unit 4: Double Pipe Heat Exchangers and Shell-and-Tube Heat Exchangers

Double-Pipe Heat Exchangers: Thermal and Hydraulic Design of Annulus and Tubes, Finned inner tubes.

Shell-and-Tube Heat Exchangers: Baffle Type and Geometry, Shell-Side Heat Transfer and Pressure Drop, Shell-Side Heat Transfer Coefficient, Shell-Side Pressure Drop, Tube-Side Pressure Drop

Unit-5: Design of Phase Change and Compact Heat Exchangers
Shell and Tube Condenser, Evaporators for Refrigeration and Air-Conditioning, Steam Turbine Exhaust Condenser, Air-Cooled Condensers.
Compact Heat Exchanger; Heat Transfer and Pressure Drop, Heat Transfer Enhancement, Plate-Fin and Tube-Fin Heat Exchangers. Performance evaluation.

Textbook(s)

1. Kakac, S. and Liu H. "Heat Exchangers: Selection, Rating and Thermal Design", CRC Press, 2nd edition, 2002.

Reference Books

1. Shah, R. K. and Sekulic, D. P., "Fundamentals of Heat Exchanger Design", John Wiley & Sons, Inc., 2003.

2. Webb, R.L., and Kim, N.H., "Principles of Enhanced Heat Transfer", Taylor and Francis, 2005.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF351**
3. Course Title	**Robotics Simulation**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:2**
6. Prerequisites (if any)	**Problem Solving and Prog.**
7. Course Basket	**DE**

8. Course Summary

This course will give the overall idea about the simulation of the industrial robotics links, which is required for the designing of the robotics manipulators.

9. Course Objectives

a. To expose the techniques for simulation of robot design and motion.

10. Course Outcomes

a. To simulate the robot functions, joint movements etc
b. To learn a simulation package and how to perform a simulation with that package
c. To prepare graphic animation sequences to describe the robotic action to be displayed
d. Velocity, acceleration analysis of Joint and linkages. It is prerequisite for inertia force analysis

11. Curriculum Content

UNIT 1: Introduction

Robotics systems, Robot movements, Quality of simulation, types of simulation, Robot applications, Robotics simulation displays. Simulation notation, Auto lisp functions. Features, Command syntax, writing design functions.

UNIT 2: ROBOTIC PRINCIPLES

Straight lines, Angles and optimal moves circular interpolation, Robotic functions Geometrical commands, Edit commands. Selecting robot views, standard Robot part, using the parts in a simulation.

UNIT 3: ROBOTICS SIMULATION.

Simulation packages, Loading the simulation, Simulation editors, delay, resume commands. Slide commands, program flow control. Robot motion control, Analysis of robot elements, Robotic linkages.

UNIT 4: ROBOTIC MOTION

Solids construction, Solid animation. Types of motion, velocity and acceleration, Types of simulation motion Harmonic motion, parabolic motion, uniform motion velocity and acceleration analysis for robots.

UNIT 5: ROBOT DESIGN

Linkages, Types, Transmission elements Flexible connectors, pulley-and-Belt drives, variable speed transmission. Design of Robot for particular applications - A case study.

Textbook(s)

1. Daniel L. Ryan, Robotics Simulation, CRC Press Inc., 1994

2. Richard D. Klafter, Thomas. A, Chri elewski, Michael Negin, Robotics Engineering an Integrated Approach, Prentice Hall of India Pvt. Ltd., 1989
3. Mikell P. Groorer, Mitchell welss, Roger N. Nagel, Nicholas G.D.D. Ray, Industrial Robotics, Technology programming and Applications, 1986

Reference Books

1. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987
2. Bernard Hogcos, Industrial Robotics, Second Edition, Jaico Publishing house
3. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, Prentice Hall of India Pvt. Ltd., 2000
4. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, Prentice Hall of India Pvt. Ltd., 2001
5. John J. Craig, Introduction to Robotics Mechanics and Control, Second Edition, Addison Wesly Longman Inc. International Student edition, 1999
6. Bijay K. Ghosh, Ning XI, T.J. Tarn, Control in Robotics and Automation Sensor - Based ingegration, Academic Press, 1999
7. Carl D. crane III and Joseph Duffy, Kinematic Analysis of Robot manipulation, Cambridge University press, 1998

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF352**
3. Course Title	**Manufacturing System Simulation**
4. Credits (L:T:P:C)	**2:1:0:3**
5. Contact Hours (L:T:P)	**2:2:0**
6. Prerequisites (if any)	Manufacturing Processes
7. Course Basket	**DE**

8. **Course Summary:** This course will give the basic of the random number generation, design and evaluation of simulation experiments with simulation languages.

9. **Course Objectives:** To highlight the basic concepts and procedure for simulation of Manufacturing systems.

10. **Course Outcomes**

On successful completion of the course, students will be able to achieve the following:

CO1: Basics of simulation and its types
CO2: Techniques for generation of random numbers
CO3: Design and evaluation of simulation experiments
CO4: Simulation languages
CO5: Concepts and simulation of discrete events

11. **Curriculum Content**

UNIT 1: INTRODUCTION
Systems - discrete and continuous systems, general systems theory, models of systems- variety of modeling approach, concept of simulation, simulation as a decision making tool, types of simulation, Principle of computer modeling- Monte Carlo simulation, Nature of computer modeling, limitations of simulation, area of application**.**

UNIT 2: RANDOM NUMBER GENERATION
Techniques for generating random numbers- mid square method, mid product method, constant multiplier technique, additive congruential method, linear congruential method. Tests for random numbers- Kolmogorov-Smirnov test, the Chi-square test.

UNIT 3: DESIGN AND EVALUATION OF SIMULATION EXPERIMENTS
Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow charts, starting condition, run size, experimental design consideration, output analysis, verification and validation of simulation models.

UNIT 4: SIMULATION LANGUAGES
Comparison and selection of simulation languages, study of any one simulation language
.

UNIT 5: DISCRETE EVENT SIMULATION
Concepts in discrete -event simulation, development of simulation models for queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network. Programming for discrete event simulation in GPSS, case studies.

Textbook(s)

1. Jerry Banks and John S Carson, Barry L Nelson, David M Nicol, 'Discrete event system simulation', Prentice Hall, India, 2000
2. Gordon G, 'System Simulation', Prentice Hall, India, 1991

Reference Books

1. Khoshnevi. B., 'Discrete system simulation', McGraw Hill International edition, 1994
2. Ronald G Askin and Charles R Standridge, 'Modeling and analysis of manufacturing systems', John Wiley & Sons, 1993
3. Thomas J Schriber., 'Simulation using GPSS', John Wiley & Sons, 1991
4. Shannon, R.E., 'System Simulation - The art and science', Prentice Hall, India, 1975

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF353**
3. Course Title	**Computational methods in thermal and fluid engineering**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:2**
6. Prerequisites (if any)	**Thermodynamics, Fluid mechanics**
7. Course Basket	**DE**

8. Course Summary

The course gives an introduction to numerical simulation of heat transfer and fluid flow problems in industrial and natural processes. Emphasis is put on learning the practical use of numerical methods. The students will learn to assess the accuracy and to interpret the meaning of the numerical results in heat transfer and fluid flow.

9. Course Objectives

- Classification of the basic equations for fluid dynamics and heat transfer.
- Discretization of transport equations for compressible and incompressible flow.
- Finite volume methods for heat transfer and fluid flow in one and more dimensions: Diffusion, advection, convection-diffusion, Euler and Navier-Stokes equations.
- Basics of Finite Element Methods
- Introduction to a computational solution tool and application to heat and fluid flow.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Numerical solution of practical problems in heat transfer and fluid dynamics.
CO2: Checking and assessing numerical methods and simulations for heat transfer and fluid flow problems.

11. Curriculum Content

UNIT 1: Mathematical description of fluid flow and heat transfer:
Basics of heat transfer, fluid flow. Mathematical description of fluid flow and heat transfer: conservation equations for mass, momentum, energy. Classification of partial differential equations, coordinate systems.

UNIT 2: Finite Difference Technique:
Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of finite difference method.

UNIT 3: Finite Volume Technique:

Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.

UNIT 4: Finite Element Methods:
Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications.

UNIT 5: Methods of Solution:
Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform. Time integration Methods: Single and multilevel methods; predictor corrector methods; stability analysis: Applications to transient conduction and advection diffusion problems. Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping.

Textbook(s)

1. Anderson, D.A., Tannehill, J.C. and Pletcher, R.H.(1997). Computational Fluid Mechanics and Heat Transfer. Taylor & Francis.

Reference Books

1. Ferziger, J. H. and Peric, M.(2003). Computational Methods for Fluid Dynamics. Third Edition,SpringerVerlag,Berlin.
2. Versteeg, H.K. and Malalasekara, W.(2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.
3. Anderson, D.A., Tannehill, J.C. and Pletcher, R.H.(1997). Computational Fluid Mechanics and Heat Transfer. Taylor & Francis.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

13. List of Experiments

1. Analysis of heat conduction in a solid object.
2. Calculation of Reynolds's number and Nusselt Number in a tube under laminar flow condition.
3. Analysis of turbulent flow in a pipe.
4. Localized Heating Analysis in a pipe flow condition.
5. The grid independence test using the parametric analysis method

1.	**Department offering the course**	**Mechanical Engineering**
2.	**Course Code**	**MEF354**
3.	**Course Title**	**POWER PLANT ENGINEERING**
4.	**Credits (L:T:P:C)**	**3:0:0:3**
5.	**Contact Hours (L:T:P)**	**3:0:0**
6.	**Prerequisites (if any)**	**THERMODYNAMICS**
7.	**Course Basket**	**DE**

8. Course Summary

This course is intended to expose the students to the applications of thermodynamics cycle and principles of turbo machine in energy generation system.

9. Course Objectives

- To analyze the economics analysis of energy generation.
- To learn about different form of energy generation and vapor cycles and their layout as per power plant
- To learn about gas cycles and their layout as per power plant.
- To learn about nuclear power plant terminology.
- To learn about hydroelectric power plant constructional details and hydrology..

10. Course Outcomes

Upon completion of the course, the students can understand the principles of operation for different power plants and their economics.

CO1: Understand the construction and working of steam generators and their accessories

CO2: Study of some power plant related equipment's

11. Curriculum Content

UNIT 1: INTRODUCTION: ECONOMICS OF POWER GENERATION.

Global trend for per capita consumption of energy, Demand of energy and future availability in usable form. Load duration curve, tariff methods for electrical energy, advantage of combined working, load division between power stations.

UNIT 2: STEAM POWER PLANT:

Analysis of steam cycles, effect of steam condition on thermal efficiency, Layout of modern coal power plant, Steam Generator, FBC boilers, Circulation-natural and Forced, circulation ratio, pulverizer and coal burners, subsystems of thermal power plants, ash handling system, Dust collection system, Feed water treatment, deaerator, condenser and cooling towers, Turbine lubrication and supervisory system, Operation and maintenance of steam power plant.

UNIT 3: GAS TURBINE POWER PLANT:

Brayton cycle analysis and optimization, combined cycle, Gas turbine fuels, cogeneration, Gas turbine power plants components, selection and governing system, comparative study with other energy generation system, Layout of gas turbine power plant, operation and maintenance.

UNIT 4: NUCLEAR ENERGY:

Principles of release of nuclear energy-Fusion and fission reactions, Nuclear fuels used in the reactors, Layout and subsystems of nuclear power plants, General components of a nuclear reactor Brief description- Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal

cooled reactors, Safety measures for nuclear power plants.

UNIT 5: HYDROELECTRIC POWER PLANTS:

Classification, typical layout and components, Hydrology, Site selection for hydroelectric power plants, Design construction and operation of different components of hydroelectric power stations.

Textbook(s)

1. S. Domkundwar, S.C. Arora., A Course in Power Plant Engineering, 6th edition.2011.
2. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 5th edition.2005.
3. El Wakil M.M., Power Plant Technology, Tata McGraw Hill.
4. Yadav,R.,Steam & Gas Turbines & Power Plant Engineering, Central Pub.House.

Reference Books

1. Power Plant Engineering- F.T. Morse
2. Steam Turbine Design and Practice- Kareton
3. Power Plant Engineering- Black and Veatch
4. Boiler Operation Engineering: Questions and Answers Hardcover – P. Chattopadhyay

12. Teaching and Learning Strategy

1. Class room delivery.
2. Power point presentation.
3. Nearby plant visit.
4. Simulation training.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF441**
3. Course Title	**Advanced Automobile Engineering**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Fundamentals of IC engine and automobile**
7. Course Basket	**DE**

8. Course Summary

The course helps student to understand the all subsystems of vehicle technologies in modern development.

9. Course Objectives

- To learn about vehicle homologation & safety design aspects
- To learn about constructional design basics, operating control characteristics of vehicle
- To learn about the critical subsystems of vehicle chassis.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Acquire vehicle sub systems design and control basics with current vehicles technology scenario.
CO2: Students will learn about homologation and vehicle safety aspects.

11. Curriculum Content

UNIT 1:
Categorization and Homologation of vehicles. Classification & Constructional details of various vehicles. Introduction to wheel loaders, ATV, sports vehicles their nomenclature

UNIT 2:
Passenger car Regulations. Basic ergonomics, driver's visibility and safety measures in vehicle design. Car body construction; design criteria. AIS testing standards, Crash tests and crumple zones.

UNIT 3:
Chassis & Controls
Vehicle frame design and its types. Vehicle Transmission Systems: Basic design principles and operational control, Antilock brake system and throttle controls, Controls on dashboard meters
Suspension system: Types of suspensions, introduction to basics of suspension analysis, types of dampers.

UNIT 4:
Vehicle pollution controls and vehicle emission norms.
Electric vehicles: Introduction, types of batteries, types of electric vehicles drives. Hybrid vehicles.

UNIT 5:
Case study on features of Indian models of PC, LCV and two wheelers and comparative analysis.

Textbook(s)

1. Automobile Engineering - Kripal Singh.
2. Automotive mechanics by Srinivasan, TMH, New Delhi
3. Automotive Technology by Sethi, TMH, New Delhi

Reference Books

1. Motor Vehicles by Newton Steeds and Garrot, Butterworths, London – 2000.
2. Mechanism of the Car by Judge A.W, Chapman and Halls Ltd., London –1986
3. Automotive Chassis and Body by Crouse W.H, McGraw –Hill, New York –1971.
4. Automobile Engg. by K.K. Jain, R.B. Asthana, TMH –2002.
5. Automotive Engineering- Hietner.

12. Teaching and Learning Strategy

All materials (Ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF442**
3. Course Title	**TURBOMACHINES**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Thermodynamics, Fluid mechanics**
7. Course Basket	**DE**

8. Course Summary

To enable the students to know the principle, construction and working operation of turbo machines for compressible and incompressible fluids.

9. Course Objectives

- To learn about basic concept of turbo machines.
- To learn about principle of energy exchange in turbo machines.
- To learn about general analysis of turbo machines.
- To learn about blade theory.
- To analyze the performance by dimensional and model analysis.

10. Course Outcomes

At the end of the course the student can:

CO1: Have thorough understanding of velocity triangles, thermodynamic plots and losses in turbo-machinery.

CO2: Solve analytical problems in turbo-machines for both compressible and incompressible fluid flows

CO3: Demonstrate the knowledge of working, stages, performance and dimensional characteristics of turbo-machinery.

11. Curriculum Content

UNIT 1: BASIC CONCEPT OF TURBOMACHINES:

Definition, Classification of Turbo machines, Basic laws and governing equations, Efficiencies of turbine and compressor with reference of stagnation properties, preheat factor in compressor and reheat factor in turbine.

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor.

UNIT 2: General Analysis of Turbo machines:

Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, General analysis of axial flow pumps and compressors.

UNIT 3: BLADE THEORY AND STEAM TURBINES

Aero foil section, Energy transfer in terms of lift and drag coefficient, blade terminology,
Velocity triangle-impulse and reaction turbine, compounding in steam turbine, Degree of reaction,
Steam turbine governing, characteristic curves. – Features of Steam turbine and Gas turbine.

UNIT 4: Fans, Blowers and Compressors

Centrifugal Compressors – component and description, velocity diagram, Stage pressure rise - Stage pressure co-efficient , slip factors ,effect of impeller shape on performance, Stalling and Surging, centrifugal and axial compressor characteristic curves.

UNIT 5: Dimensional and Model analysis:

Introduction: fundamental and derived dimension, dimensional homogeneity, Dimensional analysis method, similitude, classification of hydraulic models, specific speed of pump and turbine, Model testing of hydraulic turbo machine, unit quantities.

Textbook(s)

1. Valan Arasu,A,."Turbomachine",2nd edition,vikash publishers.
2. Pai ,B.U.,"Turbomachine",1st edition-2013,Wiley.
3. S.M. Yahya,"Turbine, Fans and Compressors, TMH, 2002.

Reference Books

1. Douglas J.F., Gasiorek, J.M and Swaffield J.A. , Fluid Mechanics, Addison – Weisly.1999
2. Dixon, S.L, , 'Fluid Mechanics and Thermodynamics of Turbomachinery', Pergamon Publishers 1999
3. Kadambi and Prasad, (1997), Energy conversion Vol. III – Turbomachines, Wiley Eastern.
4. A.H. Church and Jagadish Lal, (2000), Centrifugal Pumps and Blowers; Metropolitan Book Co, Pvt. Ltd.

12. Teaching and Learning Strategy

Class room delivery

PPT presentation.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF443**
3. Course Title	**Machine Tool Design**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Manufacturing processes**
7. Course Basket	**DE**

8. Course Summary

This course is intended to expose the students about the working mechanism of various machine tools and designing of its various components.

9. Course Objectives

To expose the students about the various constructional and operational features of machine tools and how the various structural elements are designed.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of constructional and operational features of various machine tools.
CO2: Understanding of various machine tool drive mechanism.
CO3: Designing of speed box and feed box.
CO4: Designing of various machine tools structural elements.
CO5: Basics of numerical control and machine tool testing.

11. Curriculum Content

UNIT 1: Introduction and General Principles of Machine Tool Design

Developments in machine tools, Types of machine tools, Constructional and Operational Features of basic machine tools e.g. Lathe, Drill, Milling, Shapers and Planers, Grinding machine etc., General requirement of machine tool design, Machine tool design process, Tool wear, Force Analysis.

UNIT 2: Machine Tools Drives

Classification of machine tool drives, Group vs Individual drives, Selection of electric motor, A brief review of the elements of mechanical transmission e.g. gear, belt and chain drives, slider-crank mechanism, cam mechanism, nut & screw transmission, Devices for intermittent motion, Reversing & Differential mechanisms, Couplings and clutches, Elements of hydraulic transmission system. e.g. pumps, cylinder, directional control valves, pressure valves etc., Fundamentals of kinematic structure of machine tools.

UNIT 3: Regulation of Speed and Feed rates

Laws of stepped regulation, Selection of range ratio, Standard progression ratio, Selection of best possible structural diagram, Speed chart, Design of feed box, Developing gearing diagrams, Step-less regulation of speed and feed in machine tool, Speed and feed control.

UNIT 4: Design of Machine Tool Structure

Function of machine tool structures and their requirements, Design criteria for machine tool structures, Selection of material, Basic design procedure for machine tool structures, Design of bed, column and housing, Model technique in design, Design of guide ways and power screws: basic guide way profiles, Designing guide way for stiffness and wear resistance, Hydrostatic and antifriction grand ways, Design of sliding friction power screws, Design of spindle & spindle supports, Layout of bearings, selection of bearings for machine tools.

UNIT 5: Dynamics of machine tools

General procedure for assessing the dynamic stability of cutting process, closed loop system, Chatter in machine tools. Control Systems: Functions, requirements & types of machine tool controls, Controls for speed & feed change, Automatic and manual Controls, Basics of numerical controls, Machine tool testing: Geometrical tests on Lathe, Milling and Drilling machines, their performance & significance

Textbook(s)

1. N.K. Mehta, "Machine Tool Design and Numerical Control" 3rd Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2012.

Reference Books

1. S.K. Basu and D.K. Pal, "Design of Machine Tools", 5th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2009
2. G.C. Sen and A. Bhattacharya, "Principles of Machine Tools", Second Edition, New Central Book Agency (P) Ltd., Kolkata, 2009

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF444**
3. Course Title	**Operation Research**
4. Credits (L:T:P:C)	**2:1:0:3**
5. Contact Hours (L:T:P)	**2:2:0**
6. Prerequisites (if any)	**Engineering Mathematics- I, Engineering Mathematics- II**
7. Course Basket	**DE**

8. Course Summary

Operations research helps in solving problems in different environments that needs decisions. The module cover topics that include: linear programming, Transportation, Assignment, and CPM/ MSPT techniques. Analytic techniques and computer packages will be used to solve problems facing business managers in decision environments.

9. Course Objectives

This course aims at familiarizing the students with quantitative tools and techniques, which are frequently applied to business decision-making & to provide a formal quantitative approach to problem solving and an intuition about situations where such an approach is appropriate.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Apply operations research techniques like L.P.P, scheduling and sequencing in Industrial optimization problems.

CO2: Solve transportation problems using various OR methods and illustrate the use Of OR tools in a wide range of applications in industries.

CO3: Analyse various OR models like Inventory, Queuing, Replacement, Simulation, Decision etc. and apply them for optimization.

11. Curriculum Content

UNIT 1: Linear Models

Introduction to Operations Research – Linear Programming - Mathematical Formulation –Graphical method – Simplex method – Duality – Two – Phase Simplex method –Transportation problems – Northwest Corner method– Vogel's Approximation method –MODI method – Assignment problems Applications.

UNIT 2: Sequencing and Networks

Sequencing –Problem with N jobs and 2 machines - 3 machines and 'M' machines. Network models – Basic Concepts – Construction of Networks – Project Network – CPM and PERT - Critical Path Scheduling – Crashing of Network.

UNIT 3: Inventory Models

Inventory models – Various Costs and Concepts–EOQ–Deterministic inventory models –Production models – Stochastic Inventory models – Buffer stock.

UNIT 4: Queuing Models
Queuing models – Poisson arrivals and Exponential service times – Single channel models and Multi-channel models.

UNIT 5: Decision Models
Decision models – Game theory – Two-person zero sum game – Graphic solution - Property of dominance – Algebraic solution.

Textbook(s)

2. Hira D S and Gupta P K, (2007), Operations Research, S. Chand & Sons.
3. Hamdy Taha, (2009), Operations Research: An Introduction, Pearson Education Inc.

Reference Books

3. Panneerselvan. R. (2006), Operation Research, Prentice Hall of India Pvt Ltd
4. Kanti Swarup, Gupta P.K., and Manmohan, (2004), Operations Research, S.Chand & sons.
5. P. Chattopadhyay Boiler Operation Engineering: Questions and Answers 3rd Edition Tata McGraw Hill.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF445**
3. Course Title	**Tribology**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Design of Machine Elements**
7. Course Basket	**DE**

8. Course Summary

This course is intended to expose the students to the fundamental knowledge of tribology. Students will also enable to understand about various aspects of friction, wear, hydrodynamic and hydrostatic lubrication etc.

9. Course Objectives

To know about properties of lubricants, modes of lubrication, additives etc.
- To select suitable/proper grade lubricant for specific application.
- To select suitable material combination for tribological contact.
- To apply the basic theories of friction, wear and lubrications about frictional behaviour commonly encountered sliding surfaces.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: To develop an understanding of basic knowledge of tribology.
CO2: Understand the basic fundamentals of friction and wear.
CO3: Learn about various aspects of hydrodynamic lubrication.
CO4: Understand the fundamental concept of hydrostatic and gas lubrication.
CO5: To develop an understanding of various tribological aspects.

11. Curriculum Content

UNIT 1: Introduction

Tribology definition. Tribology in design- bearing material its properties and construction Tribological characteristics of oil seals and gasket. Tribology in industry (Maintenance).
Lubrication-Definition, basic modes of lubrication, properties of lubricants, additives, EP lubricants, Recycling of used oil, oil conservation. Bearing Terminology-Types of Sliding contact, rolling contact bearings. Comparison between sliding and rolling contact bearing. (Theoretical treatment only).

UNIT 2: Friction and wear

Introduction, laws of friction, Friction classification, causes of friction. Theories of dry friction. Friction measurement. Stick-slip motion and friction instabilities.
Wear-classification, wear between solids, wear between solid and liquids, factors affecting wear. Theories of wear. Wear measurement. Controlling friction.

UNIT 3: Hydrodynamic lubrication

Theory of hydrodynamic lubrication, mechanism of pressure development in oil film. Two dimensional Reynold‘s equation and its limitations, Petroff`s equation. Designing journal Bearing. Hydrodynamic thrust bearing-Introduction, types. Flat plate thrust bearing-Pressure equation, load, and centre of pressure.

UNIT 4: Hydrostatic lubrication and Gas (Air) lubrication
Hydrostatic lubrication-Basic concept, advantages, limitations, viscous flow, load carrying capacity, flow requirement of hydrostatic step bearing, energy losses, design concepts of stepped bearing. Squeeze film lubrication- Basic concept, circular and rectangular plate approaching a plane.
Gas(air) lubricated bearings-Introduction, advantages, disadvantages, applications of tilting pad bearing, hydrostatic and hydrodynamic bearing with air lubrication.

UNIT 5: Tribological Aspects
Lubrication in rolling, forging, drawing and extrusion. Theory of tyre road interaction, road grip. Surface engineering for wear and corrosion resistance-diffusion, plating and coating methods.

Textbook(s)

4. Bharat Bhushan, ― Principles and Applications of Tribology, 2nd Edition, Wiley India.

Reference Books

1. Cameron A., ―Basic Lubrication Theory‖, Wiley Eastern Ltd.
2. Mujumdar B. C., ―Introduction to Tribology and Bearings‖, S. Chand and Company Ltd. New Delhi.
3. Fuller D. D., ―Theory and Practice of Lubrication for Engineers‖, John Wiley and Sons.
4. Halling J., ―Principles of Tribology‖, McMillan Press Ltd.
5. Bhushan B. and Gupta B. K., ― Handbook of Tribology: Material, Coatings and SurfaceTreatments‖, McGraw Hill Ltd.

12. Teaching and Learning Strategy
All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF446**
3. Course Title	**Product Design & Development**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Manufacturing Processes**
7. Course Basket	**DE**

8. Course Summary: This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

9. Course Objectives:

- To learn the Product Design and Innovation
- To learn overall awareness of the product design process.
- To learn methods, tools and techniques applied in product design.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1:To understand the innovation, product design process, user study, need/problem identification, development of design brief,

CO2: To understand competitive benchmarking, aspects of human factors in product design, tools for creative concept generation, and prototyping/model making and evaluation techniques for user-product interaction.

CO3:This course will be explained with lectures including case studies and hands-on exercises. This will help students to generate creative ideas in to product design, considering human factors aspects.

11. Curriculum Content

UNIT 1:

Significance of product design, Need for developing products, product design and development process, the importance of engineering design, sequential engineering design method, relevance of product lifecycle issues in design, the challenges of product development.

Product Planning and Project Selection: generic product development process, Identifying opportunities, evaluate and prioritize projects, allocation of resources, various phases of product development-planning for products.

UNIT 2:

Identifying Customer Needs voice of customer, customer populations, Interpret raw data in terms of customers need, hierarchy of human needs, need gathering methods, establish the relative importance of needs.

Product Specifications: Establish target specifications, setting final specifications

Concept Generation: Activities of concept generation, clarifying problem, search both internally and externally, explore the output

UNIT 3:

Industrial Design: Assessing need for industrial design, industrial design process, management, assessing quality of industrial design, human factors design, user friendly design

Concept Selection: Overview, concept screening and concept scoring, methods of selection, case studies.

UNIT 4:

Theory of inventive problem solving (TRIZ): Fundamentals, methods and techniques, General Theory of Innovation and TRIZ, Value engineering Applications in Product development and design, Model based technology for generating innovative ideas measurement of customers response.

Concept Testing: Elements of testing: qualitative and quantitative methods including survey.

UNIT 5:

Intellectual Property: Elements and outline, patenting procedures, claim procedure.

Design for Environment: Impact, regulations from government, ISO system, case studies.

Text book [TB]:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development", Tata McGraw-Hill Education, 4th Edition, 2009.
2. Kevin Otto, Kristin Wood, "Product Design", Pearson Education, Indian Reprint 2004.

REFERENCES [RB]:

1. Yousef Haik, T. M. M. Shahin, "Engineering Design Process Cengage Learning, 2010", 2nd Edition Reprint.
2. Kevin Otto, Kristin Wood, "Product Design", Pearson Education Indian Reprint 2004.
3. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", John Wiley & Sons, 3rd Edition 2009.

12 Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF447**
3. Course Title	**Design of Hydraulics & Pneumatics systems**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:2**
6. Prerequisites (if any)	**Fluid Mechanics, Fluid Machines**
7. Course Basket	**DE**

8. Course Summary:

The subject gives in-depth knowledge of different system working on fluid power and compressed air with understanding of different valves used in the hydraulic and pneumatic system.

9. Course Objectives:

- To learn and analyse operation of industrial fluid power and pneumatics systems,
- To learn the design, application, and trouble-shooting.
- To learn hydraulic or pneumatic circuit or combination circuit like electro-hydraulics.

10. Course Outcomes:

On successful completion of the course, students will be able to achieve the following:

CO1: To Develop a circuit diagram for Pneumatics systems

CO2: Identify different symbols of components used in hydraulic and pneumatic system.

CO3: Selection and sizing of components of the circuit.

11.Curriculum Content:

UNIT 1: Introduction

Mechanization vs. Automation, low cost automation with hydraulics and pneumatics. Requirement of industrial automation with hydraulics and pneumatics.

Basic pneumatics and hydraulics system: Fundamentals and basic principal of Hydraulics, advantages and disadvantages, pneumatics power vs. hydraulics power, overview of basic pneumatics and basic hydraulic systems.

UNIT 2: Hydraulic and pneumatic Actuators

Pumps and compressors: Pumps vs. compressor, classification of pumps, positive displacement pumps, rotary pumps, and reciprocating pumps, centrifugal pumps. Pump selection parameters. Types of air compressors, positive displacement compressor, rotary compressor, reciprocating compressor.

Cylinders and motors: Symbolic representation of motors and cylinders, cylinder classification on the basic of construction, single acting cylinder, double acting cylinder, other types of cylinders. Hydraulic and pneumatics cylinders, cylinder sizing, types of motors, motor rating, gear motors and vane motors

UNIT 3: Fluid Accessories and control valves

Fluid Accessories: Air receiver, air dryer, air filter, Pressure regulator, Air service unit (FRL), Seals, hydraulic filters, accumulator, intensifier, Hoses ,pressure gauge.

Control Valves: Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Sequence valve, pneumatic logic valve, shuttle and servo valves, Selection of valves for circuits,

Symbolic representation of control valves and fluid accessories.

UNIT 4: Design of pneumatic circuits

Pneumatics circuits for control of single acting cylinder and double acting cylinder. Circuit with mechanical feedback, speed control circuit, use of flow control valve, quick exhaust valve in pneumatics circuits. Application with twin pressure and shuttle valves. Sequencing and cascading method for two and three cylinder application.

UNIT 5: Design of hydraulic circuits

Hydraulic circuits for control of single acting cylinder and double acting cylinder. Circuit with mechanical feedback, speed control circuit, use of flow control valve, quick exhaust valve in hydraulic circuits. Application with twin pressure and shuttle valves. Designing of Sequencing and cascading circuit for two and three cylinder application.

Text book [TB]:

1. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw Hill. 2010
2. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.2006
3. Fluid Power with Applications by Anthony Esposito, Pearson. 2010
4. Industrial automation and robotics by A.K.Gupta , University science press.1012

Reference books [RB]:

1. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.2010
2. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.2009
3. Control of Fluid Power Analysis and Design by Mc Clay Donaldson, Ellis Horwood Ltd.2006
4. Hydraulic and Pneumatic Controls: Understanding made Easy, K.Shanmuga Sundaram, S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
5. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
6. Basic fluid power Dudley, A. Pease and John J. Pippenger, , Prentice Hall, 1987

12 Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF448**
3. Course Title	**Computer Integrated Manufacturing**
4. Credits (L:T:P:C)	**2:0:2:3**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**Manufacturing Processes**
7. Course Basket	**DC**

8. Course Summary

This course is intended to expose the students to the applications of computer in the manufacturing field and to give the overall idea of the various techniques in the manufacturing to make it easier and computer based.

9. Course Objectives

a. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.

b. To make students to understand the Computer Applications in Design and Manufacturing [CAD /CAM) leading to Computer integrated systems. Enable them to perform various transformations of entities on display devices.

c. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen
CO2: Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines.
CO3: Analyze the automated flow lines to reduce time and enhance productivity.
CO4: Explain the use of different computer applications in manufacturing, and able to prepare part programs for simple jobs on CNC machine tools and robot programming.
CO5: Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

UNIT – I

Introduction- Concepts of CIM, Manufacturing system, components of CIM, CASA/SME model of CIM, CIM II, Benefits of CIM, Communication matrix in CIM, Fundamentals of computer communication in CIM, computer networking in CIM- seven layers of OSI model.

UNIT – II

NC & CNC part programming: Fundamental of NC technology, computer numerical control, distributed numerical control, coding systems and formats, Manual NC part programming, Examples drilling and milling, turning, CNC machines and turning centers, CNC part programming.

UNIT – III

Material Handling System -introduction to material handling, material transport equipment like industrial trucks, automated guided vehicles, monorail and other rail guided vehicles, conveyors, cranes and hoists.AS/RS design process Identification technologies- introduction, bar code technology, radio frequency identification.

UNIT – IV

Flexible manufacturing systems: introduction, FMS components, equipment's, FMS tool

management systems, system layout, FMS control, case study. FMS applications and benefits. Group technology and cellular Manufacturing: part families, part classification and coding Production flow analysis, application of Group technology.

UNIT – V

Process planning and Concurrent Engineering- process planning, computer aided process planning, concurrent engineering and design for manufacturing, advance manufacturing planning, Production Planning and Control systems- Aggregate production planning and the Master Production schedule, Material Requirement planning, Shop floor control, Inventory control, JUST IN TIME, Lean and Agile manufacturing.

Text Books:

1. Rao P N,"CAD/CAM Principles and Applications "third edition, McGraw Hill Education Pvt.Ltd.

Reference Books:

1. Groover. Mikell P, "Automation, Production systems and computer integrated manufacturing", Third edition, PHI learning private limited, ISBN-978-81-203-3418-2.
2. Groover .Mikell P and Zimmers jr. Emory, "CAD/CAM", Prentice hall of India Pvt Ltd., 1998.
3. James A, Regh and Henry W. Kreabber "Computer integrated manufacturing" Pearson Education 2 nded, 2005.
4. Paul G. Ranky., "Computer Integrated Manufacturing", Prentice hall of India Pvt Ltd., 2005.

11. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

12. List of Experiments:

1. Study of Flexible manufacturing system

2. Writing a part-programming (in word address forma tor in APT) for a job for turning operation and running on NC machine.

3. Writing a part-programming (in word address format or in APT) for a job for drilling operation (point-to point) and running on NC machine.

4. Writing a part programming (in word address format or in APT) for a job for milling operation (contouring) and running on NC machine

5. Experiment on Robots and it programs

6. Experiment on Transfer line/Material handling (AS/RS).

7. Experiment on difference between ordinary machine and NC machine.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF381**
3. Course Title	**Composite materials**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Strength of Materials, Engineering Materials**
7. Course Basket	**FE**

8. Course Summary

This course enable the students to know and understand the mechanical behavior of composite materials.

9. Course Objectives

The objective of the course is to introduce the fundamental knowledge on the processes used for manufacturing of composites. This also introduces the applications of such processes.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understand the mechanical behaviour and application of composite materials.
CO2: Know the methods of manufacturing composite materials.
CO3: Understand various mechanics of composite materials.

11. Curriculum Content

UNIT 1:

Definition and applications of composite materials, classifications, Fibers- glass, carbon, ceramic and aramid fibers. Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Fillers and whiskers. Advantages and limitations of composites

UNIT 2:

Mechanical behaviour of composite materials, surface treatment of fibers, thermosets matrix materials, Thermoplastics and other matrix materials, Manufacturing of thermoset composites, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes

UNIT 3:

Composite mechanics Terminology, Behaviour of unidirectional composites, Behaviour of short fiber composites Analysis of orthotropic ply. Hook's Law for orthotropic lamina, Relation between Engg. constants and Elements of matrices for orthotropic ply, Transformation of Engg. constants, Failure in isotropic materials

UNIT 4:

Analysis of laminated composites, symmetric laminates, angle ply laminates, cross ply laminates, laminate, evaluation of lamina properties, determination of stress and strain in laminate, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, .

UNIT 5:

Residual stresses during curing, prediction of laminate failure, thermal analysis of composite laminates. Analysis of laminated plates - equilibrium equations of motion, static bending analysis, buckling analysis, free vibrations, natural frequencies.

Textbook(s)

5. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
6. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.

Reference Books

7. F. L. Matthews, Rees D. Rawlings , Composite Materials: Engineering and Science Woodhead Publishing, 1999.
8. Autar K. Kaw**,** Mechanics of Composite Materials, CRC Press, 1997.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF481**
3. Course Title	**Total Quality Management**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Manufacturing Process, Industrial Engineering.**
7. Course Basket	**FE**

8. Course Summary

To course intends the introduction of concepts of quality in design, manufacturing and inspection.

9. Course Objectives

- To understand the concept and philosophy of quality management.
- To know the applications of quality management.
- To know the quality function deployment, six sigma, process capability, just-in-time philosophy.
- To know the quality circles, quality system.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: To facilitate the understanding of total quality management principles and processes.
CO2: Student will learn about ISO systems.
CO3: Student will learn about various quality tools to improve products quality.

11. Curriculum Content

UNIT 1:

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

UNIT 2:

TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

UNIT 3:

The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

UNIT 4:

TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

UNIT 5:

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

Textbook(s)

7. Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
8. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
9. Subburaj Ramasamy, Total quality management, McGraw-Hill Education, 2012.

Reference Books

9. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
10. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF482**
3. Course Title	**Renewable Energy Sources**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**Thermodynamics, Heat Transfer**
7. Course Basket	**FE**

8. Course Summary

This course is designed to provide students an overview of global energy resources with focus on renewable energy sources and their importance in the context of limited supply of conventional energy resources & global warming.

9. Course Objectives

- To provide an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternative energy sources and their technology and application.
- To explore society's requirements of energy by alternatives, renewable energy sources.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understand about the interaction between energy, economy, environment, and social development.

CO2: Appreciate the importance of renewable energy sources & future energy systems based on them.

CO3: Possess the basic technical knowledge to develop energy systems based on solar, biomass, wind, geothermal & ocean energy.

11. Curriculum Content

UNIT 1: ENERGY RESOURCES

Introduction: Energy & its importance in social & economic development; energy demand & supply, world energy status, energy scenario in India; energy & environment, greenhouse effect & global warming; role of renewable energy sources; a brief introduction to various renewable energy sources – hydro, solar, biomass, wind, geothermal & ocean energy – their availability & present status.

UNIT 2: SOLAR ENERGY

The sun as a source of energy, extraterrestrial & terrestrial solar radiation; solar radiation data & geometry, solar radiation on horizontal & inclined surfaces; solar thermal systems – various types of solar collectors & their applications in cooking, drying, water heating, distillation, space heating & cooling, refrigeration and power generation.

Solar photovoltaic systems, solar cell fundamentals, performance & characteristics, types of solar cells; solar cell, module, and array construction; solar PV applications.

UNIT 3: BIOMASS ENERGY

Origin of biomass, photosynthesis & generation of biomass, availability of biomass, usable forms of biomass – fuel wood, charcoal, fuel pellets, biodiesel, bioethanol, biogas and producer gas; biomass conversion technologies, thermochemical & biochemical methods, biomass gasification, classification & operational parameters of biogas plants, energy recovery from urban waste, sewage to energy conversion.

UNIT 4: WIND ENERGY

Origin & nature of winds; history of power from winds; global & local winds; estimation of wind energy at a site; maximum power extraction from wind – Betz criterion; capacity factor of wind power plants; types of wind turbines – horizontal and vertical axis wind turbines; wind energy storage; environmental & economic aspects; present status of wind energy systems.

UNIT 5: GEOTHERMAL & OCEAN ENERGY

Structure of earth's interior; origin & distribution of geothermal energy, types of geothermal resources – exploration & development of hydrothermal, geo-pressured & hot dry rock resources; electrical power generation from geothermal energy; environmental & economic considerations.

Ocean energy; tidal, wave & ocean thermal energy, energy from tidal streams (marine currents); technology for harnessing tidal & wave energy; ocean thermal energy conversion technology.

Textbook(s)

10. B. H. Khan, "Non-Conventional Energy Resources", 3rd edition (2017), McGraw Hill Education (India) Private Limited, Chennai.
11. S. P. Sukhatme & J. K. Nayak,"Solar Energy", 4th edition (2018), McGraw Hill Education (India) Private Limited, Chennai.

Reference Books

11. G. N. Tiwari & M. K. Ghosal, "Renewable Energy Resources – Basic Principles and Applications", 2005, Narosa Publishing House, New Delhi.
12. D.P. KOTHARI, K. C. SINGAL, RAKESH RANJAN, Renewable Energy Sources And Emerging Technologies, PHI Learning Pvt. Ltd., 2011.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF307**
3. Course Title	**Measurement Techniques in Mechanical Engineering**
4. Credits (L:T:P:C)	**2:0:4:4**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**Measurement and Metrology**
7. Course Basket	**SEC**

8. Course Summary

Introduction of metrology, importance of metrology and its applications in engineering. Metrology and calibration. Measuring instruments in manufacturing. Compass, its kinds, calibration and measuring applications. Micrometer, its kinds, calibration and measuring applications. Template, its kinds and applications. Surface roughness measuring. Coordinate metrology and macro geometry measurements. Analysis of experimental data and statistical evaluation. Quality standards, quality concept and quality techniques. Quality control, inspection and tests. Quality insurance. Quality improvement methods.

9. Course Objectives

- To give some knowledge about basic principles of measurement.
- To develop skills in team studies.
- To teach the principles of operation, calibration techniques and application guidelines for basic measurement equipment.
- TO teach how to use various measurement techniques.
- To give information about measurement system design and their application.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understanding of various mechanical measurement techniques.
CO2: Analyze of different measurement euipments and calibration systems.

11. Curriculum Content

UNIT 1: Basics of experimental work

BASIC MEASUREMENT CONCEPTS: Definition of measurement. Generalized measurement systems. Definition of terms used in measurement systems. Dimension and unit analysis.

MATHEMATICAL ANALYSIS OF MEASUREMENT SYSTEMS:

Static and dynamic behaviour of measurement systems. Form of input signals. Mathematical analysis of 0th, 1st, and 2nd order systems.

UNIT 2: ANALYSIS OF EXPERIMENTAL DATA:

Causes and types of experimental errors. Error analysis on a commonsense basis. Uncertainty analysis. Statistical analysis of experimental data. Gaussian or normal error distribution. Equation fitting to experimental data. Method of least squares.

UNIT 3: PRESSURE MEASUREMENT:

Pressure measurement devices utilizing differential fluid height: U-tube, well-type, tilted well-type manometers. Barometer. Pressure measurement devices utilizing elastic materials: Bourdan-tube, diaphragm, bellows. Converting mechanical displacement into electrical signal. Bridgman pressure gage. Pressure measurement for flowing fluids. Dead-weight calibration device.

UNIT 4: TEMPERATURE MEASUREMENT:

Temperature measurement with mechanical effects: fluid in glass tube thermometer, pressure thermometer, and bimetallic strip thermometer. Temperature measurement with electrical effects: electrical resistance thermometer, thermistors, and thermocouples.

Effects of heat transfer on temperature measurement. Transient response of thermometers. Temperature measurement by radiation and paint colour change.

UNIT 5: FORCE AND STRAIN MEASUREMENT:

Force, torque, and strain measurements. Force measurement with elastic materials. Torque measurement. Strain measurement. Strain gages: rectangular and delta configurations. Maximum and minimum stresses.

Textbook(s)

13. Experimental Methods for Engineers, J. P. Holman, Fifth Ed., McGraw-Hill, 1989.

Reference Books

1. E. O. Doebelin, “Measurement Systems: Application and Design”, Fourth Ed., McGraw-Hill, 1990
2. T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard, “Mechanical Measurements”

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF308**
3. Course Title	**CNC machining technology**
4. Credits (L:T:P:C)	**2:0:4:4**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**Manufacturing processes**
7. Course Basket	**SEC**

8. Course Summary

The course exposes the students to different CNC machining technologies.

9. Course Objectives

- To explain principle of CNC machine tools
- To describe construction of CNC machine tools
- To practice simple programs for CNC turning and machining centres
- To generate CNC programs for popular CNC controllers

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understand evolution and principle of CNC machine tools.
CO2: Describe constructional features of CNC machine tools.
CO3: Explain drives and positional transducers used in CNC machine tools.
CO4: Write simple programs for CNC turning and machining centres.
CO5: Generate CNC programs for popular CNC controllers.
CO6: Describe tooling and work holding devices for CNC machine tools.

11. Curriculum Content

UNIT I : INTRODUCTION TO CNC MACHINE TOOLS
Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection.

UNIT II : STRUCTURE OF CNC MACHINE TOOL
CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings.

UNIT III: DRIVES AND CONTROLS
Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer.

Textbook(s)

1. Radhakrishnan P, "Computer Numerical Control Machines", New Central Book Agency, 2002.

Reference Books

1. HMT, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi,2005.
2. Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Thomson Delmar, 2002.
3. James Madison, "CNC Machining Hand Book", Industrial Press Inc., 1996.
4. Ken Evans, John Polywka & Stanley Gabrel, "Programming of CNC Machines", Second Edition, Industrial Press Inc, New York, 2002.
5. Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000.

12. Teaching and Learning Strategy

All materials (Exercise, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

Course Structure & Syllabus of B.Tech.– Mechanical Engg.
Applicable for Batch: 2020-24

1. Department offering the course	**Mechanical Engineering**
2. Course Code	**MEF309**
3. Course Title	**Computer aided design and drafting of Mechanical components**
4. Credits (L:T:P:C)	**2:0:4:4**
5. Contact Hours (L:T:P)	**2:0:4**
6. Prerequisites (if any)	**CAD**
7. Course Basket	**SEC**

8. Course Summary

In this competency-based course students will learn the fundamentals of drafting in a modern, networked, computer lab using AutoCAD drafting software. The course will cover the concepts and application of orthographic projection, isometric representation, and basic dimensioning. Topics also include line type conventions, lettering, freehand drafting, geometric construction, sections, and auxiliary views. Students will be introduced to 3-D visualization using computer wire frame and surface modelling techniques. Advanced students will learn 3-D modelling techniques and have the opportunity to use Auto Desk's Inventor Software. This course includes classroom instruction and laboratory activities.

9. Course Objectives

In this course students will:

- Demonstrate a basic knowledge of CAD and the ability to use appropriate technique and procedures for the care and use of hardware and software to produce a series of orthographic and isometric drawings.
- Learn the importance of developing precise basic entities and will demonstrate the ability to produce accurate drawings, using computer techniques and procedures.
- Learn the function of editing commands and will demonstrate the ability to use edit commands to produce accurate drawings.
- Demonstrate an understanding of zoom, pan, views, layers, colour units, windows, grids, snaps, and command functions. The student will demonstrate the ability to manipulate geometric entities on the monitor and to produce a drawing.
- Learn the proper technique of scaling and plotting to proper size and will be able to demonstrate that ability by plotting industry-quality drawings.
- Learn the history of drafting as a graphic language, will be able to identify early drafting tools and implements, and will understand why CAD is presently used.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

CO1: Understand Part and Assembly Drawing Concepts Engineering Drawing and it's Classification.
CO2: Be able to specify dimensions, and dimensional tolerances, Surface finish.
C03: Develop Drafting and Modelling skills using design software.
CO4: Develop the 3D model using the software.

11. Curriculum Content

UNIT 1: Machine Drawing Conventions

Need for drawing conventions, introduction to IS Conventions;
a) Conventional representation of materials and common machine components.
b) Representation of geometrical and dimensional tolerance.
c) Representation of surface roughness and direction of lay of machining.

d) Representation of welded joints.
e) Sectional views and sectioning.

UNIT 2: Computer aided Drafting
Generation of points, lines, curves, polygons, dimensioning, utility commands etc. Use of modelling software.

UNIT 3: Drawing of Machine Elements and simple parts
Views of all the sets of the following machine elements and parts;
a) Popular forms of Screw threads, bolts, nuts, stud bolts.
b) Keys, cotter joints and knuckle joint.
c) Shaft coupling, spigot and socket pipe joint.
d) Journal, pivot and collar and foot step bearings.
e) Rivet joints for plates

UNIT 4: Assembly Drawings
Drawings of assembled views for the part drawings of the following using
Conventions and easy drawing proportions;
a) Engine parts – stuffing boxes, cross heads, connecting rod, and piston assembly.
b) Other machine parts - Screws jacks, Machine Vices, Plummer block, Tailstock.
c) Valves: Steam stop valve, spring loaded safety valve, feed check valve and air cock.

Textbook(s)

2. Bhatt. N. D. and Panchal.V.M. **"Machine Drawing"**; Charotar Publishing House Pvt. Ltd. Anand (Gujrat), 388001, 49th Edition, 2014.
3. Dhawan R.K, **"A Textbook of Machine Drawing";** S. Chand Publishing, New Delhi-110055.

Reference Books

6. Narayana. K.L, Kannaiah P. & Reddy K. Venkata, **"Machine Drawing"**; New Age International (P) Ltd. Publishers, New Delhi-110002, 4th Edition, 2012.
7. Gill P.S, **"A Textbook of Machine Drawing"**; S. K. Kataria & Sons Publishers, New Delhi-110002, 18th Edition, 2013.
8. Sidheswar. N, Kannaiah. P, & Sastry V.V.S., **"Machine Drawing";** McGraw-Hill Education (India) Private Limited, New Delhi-110016, 2001
9. John. K.C, **"A Textbook of Machine Drawing";** PHI Learning, Delhi.

12. Teaching and Learning Strategy
All materials (Exercise, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF281**
3. Course Title	**Introduction to Psychology**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

This course will highlight the most interesting scientific findings and insights of psychology, discussing the implications of those for our understanding of the human mind and human behaviour. We will explore some of the cognitive abilities including memory, learning, attention, perception and consciousness. We will examine the trajectory of growth of psychological perspectives. By the end of this course you will have gained a fascinating understanding and appreciation of who you are and how you work and relate with others. And I can guarantee you that you'll learn things that you'll be telling your friends and family about, things that will fundamentally change the way you think of yourself and others.

9. Course Objectives

The purpose of this course provides coverage for the broad range of learning outcomes that may be taught in introductory psychology courses. With the goal of supporting faculty in the selection of content for their courses, we have organized this course around the 5 pillars, or domains, of psychology as recently recommended by the American Psychological Association: biological pillar, cognitive pillar, developmental pillar, and social and personality pillar, mental and physical health pillar.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Identify the various approaches, fields, and subfields of psychology along with their major concepts and important figures
2. Describe the strengths and weaknesses of descriptive, experimental, and correlational research
3. Explain how nature, nurture, and epigenetics influence personality and behaviour
4. Explain the physical, cognitive, and emotional development that occurs from infancy through childhood
5. Recognize aspects of social psychology, including the fundamental attribution error, biases, social roles, and social norms, in your daily life.

11. Curriculum Content

Unit 1 Introduction

Definition, Scope, Perspectives: biological, psychoanalytic, behavioural, cognitive, humanistic, Methods: experiment, case study.

Unit 2 Cognitive Processes

Perception: Meaning, laws of perceptual organization, identifying perceptual errors; Techniques for improving our behaviors: Classical conditioning, Reinforcement theory & Modeling; Creative Thinking & Problem-Solving

Unit 3 Motivation and Emotion

Motivation: definition, self-motivation through goal setting, self-regulation, motivating employees, improving confidence; Emotion: definition, types, emotion and health, assessing emotional intelligence, body language.

Unit-4 Human abilities

Self & Personality: definition, approaches for assessment, exploration through JOHARI Window; Understanding intelligence; Stress: meaning & coping; Conflict: definition & resolution;

TEXT BOOKS

1. Baron, R.A. and Misra, G., Psychology (Indian Subcontinent Edition). Person Education Ltd. (2014)
2. Chadha, N.K. & Seth, S., The Psychological Realm: An Introduction. Pinnacle Learning, New Delhi. (2014)

REFERENCE BOOKS

1. Ciccarelli, S.K. & Meyer, G.E., Psychology (South Asian Edition). New Delhi: Tata Mc Graw Hill. (2008).\
2. Glassman, W.F., Approaches to Psychology (3rd Ed.) Buckingham: Open University Press. (2000).
3. Passer, M.W., Smith, R.E., Holt, N. and Bremmer, A., Psychology: The Science of Mind and Behaviour, McGraw-Hill Education, UK. (2008).

12. Teaching and Learning Strategy

All materials (PPTs, Assignments, Seminars, etc.) will be uploaded in Moodle.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF282**
3. Course Title	**Human Values**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

This course will introduce students to the nature of the individual and the relationship between the self and the community. It includes Principles of Interdependence between individuals and society and role of material values in promoting human well-being. It also includes psychological and spiritual values through topics like Humanistic Psychology, religion, concept of Dharma and Spirituality morality, Professional values and developing an open and balanced mind.

9. Course Objectives

To inculcate the skills of ethical decision making and then to apply these skills to the real and current challenges of the Engineering profession. The main objective of the course is to enable the students to understand the need and importance of value-education and education for Human Rights. It also aims to develop their inter personal and leadership skills and empower them to develop into evolved human beings.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Students will become more sensitive to their surroundings including both people and nature, with commitment towards what they believe in (human values).
2. Be able to understand how universal values can be uncovered by different means, including scientific investigation, historical research, or public debate and deliberation (what some philosophers call a dialectic method).
3. They will become more aware of their self and their relationships and have better reflective and discerning ability.
4. Be able to understand and discuss the idea of moral relativism and the challenges it poses to universal values.

11. Curriculum Content

Unit 1 INTRODUCTION

Nature of Value-Crisis in the contemporary Indian society, Meaning, Nature & Types of Values; Sources of Value Formation, Foundational Human Values – Integrity, Freedom, Creativity, Morals, Love and Wisdom, Case Studies Case Studies on the above aspects

Unit 2 SOCIETAL VALUES & MATERIAL VALUES

Definition of Society, Units of Society, and Social Consciousness. Concepts & Principles of Interdependence, Conceptualizing 'Good Society' and 'Social Goods' and Corporate Social Responsibility, Role of Material Values in promoting Human Well-being. Role of Science and Technology; Problems of Material Development, Case Studies Case Studies on the above aspects

Unit 3 PSYCHOLOGICAL & SPIRITUAL VALUES

Humanistic Psychology; Concept of Intelligence, Emotional Intelligence & Mental health; Cognitive Dissonance & Ego Defense, Maslow's Hierarchy of Human Need; Characteristics of 'Self-Actualizing' persons; Understanding Common Religion & Concept of Dharma and Spirituality; Case Studies Case Studies on the above aspects

Unit 4 PSYCHOLOGICAL & SPIRITUAL VALUES

Bases for moral Judgments: Customary Morality, Religious Morality, Reflective Morality. Concept of Professional values: Competence , Confidence , Devotion to Duty, Efficiency , Accountability , Respect for learning / Learned , Willingness to Learn, Open and Balanced mind; Team spirit ; Willingness for Discussion, Aims, Effort , Avoidance of Procrastination and Slothfulness, Alertness, IEEE; Case Studies Case Studies on the above aspects

Textbook(s)

1. Human Values - Prof. A.N.Tripathi New Age International, 2009

Reference Books

1. Human Values and Professional Ethics - Jayshree, Suresh and B.S. Raghwan , S. Chand Publication, 2011-12

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF283**
3. Course Title	**Literature, Language & Society**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

This course will introduce students about the literature, language & society. It also includes the overview of aspects of literature and language with its impact on the society. The course explores the dimensions of literature, its nature and its functions with its approaches to the study of society. It explores the role of language and literature in the society. The course will through study of text, also analyse the practical aspect of it.

9. Course Objectives

The main objective of the course is to focus is on the interaction between literature & Society, and Literature and visual culture. This course is also about how Literature reacts to major changes in society. This course offers the students to experience different dimension of literature and language.

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10 Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Students will read critically from a variety of genres, specifically poetry, drama, non-fiction, and fiction.
2. Students will read literature more carefully and meaningfully, practicing close-reading skills.
3. Students will understand the relation between historical and cultural contexts.
4. The students will develop a critical understanding of how literature can both uphold and resist existing structures of power.

11. Curriculum Content

Unit 1:
Nature and Functions of Literature, Literature and Society with special reference to Indian Literature and Indian Society, Literary Forms, Poetry, Drama, Fiction, Essay, Autobiography

Unit 2:
Approaches to the Study of Literature, Reader response to the study of Literature, Interpretation, Appreciation, Evaluation, Special problems in understanding Modern Literature.

Unit 3:
Social dimension of language. problems of multilingual communities, dominance and conflict, shift and attrition, language and the state, language and nation, Indian multilingualism, language variation,

language and identity, linguistic prejudice and inequality, standardization, linguistic determinism, critical discourse analysis, and methodological issues.

Unit 4:
Jerome K Jerome: Three Men on a Bummel (selection), Martin Amis: Last Days of Muhammad Atta, Li Ho: A Girl Comb her hair, R.K. Narayan: Malgudi Days (selection)

Textbook(s)

1. Jerome K Jerome: Three Men on a Bummel (selection), Arrow smith Publications.
2. R.K. Narayan: Malgudi Days (selection), I*ndian Thought Publications.*

Reference Books

1. Martin Montgomery, An Introduction to Language and Society (Studies in Culture and Communication) Routledge; 2 edition (December 22, 1995).
2. Robe Pope, *An Introduction to Language Literature and Culture*.Routledge, 2005.

1. **Teaching and Learning Strategy**
   All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF284**
3. Course Title	**Principles of Management**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

This course will introduce students about the basic Principles needed for management. It also includes case studies where a student can get idea about the actual working of the management field. Topics include Overview of Management, Management Information, and Planning Approach to Organizational Analysis, Motivation and Productivity.

9 Course Objectives

The objective of this course is to familiarize B.Tech. Students with the roles, responsibilities, and skills required of modern managers. This course will be present the concepts of management as it applies to current thinking in the workplace.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

- To present the topics in management, management theories, while at the same time focusing on practical applications in the real world especially for engineers.
- Evaluate the global context for taking managerial actions of planning, organizing and controlling.
- Assess global situation, including opportunities and threats that will impact management of an organization.
- Integrate management principles into management practices.

11. Curriculum Content

Unit 1 Overview of management

Definition-Management-Role of managers-Organization and the internal and environmental factors – Trends and Challenges of Management in India.
Directing – delegation –span of control– communication, Controlling

Unit 2 Management Information

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management

Unit 3 Planning Approach to Organizational Analysis

Design of organization structure; job design and enrichment; job evaluation and merit rating

Unit 4 Motivation and Productivity

Theories of motivation, Leadership styles and Managerial grid. Co-ordination, monitoring and control in organizations. Techniques of control; Few Cases on current management issues in India

TEXT BOOKS:

1. Schermerhorn, Management and Organisational Behaviour essentials, Wiley India
2. Koontz: Essentials of Management, PHI Learning.
3. Hirschey: Managerial Economics, Cengage Learning.
4. A V Rau: Management Science, BSP, Hyderabad
5. Mote, l Paul and Gupta: Managerial Economics Concepts & Cases, TMH, New Delhi.
6. Stephan R Robbins Fundamental of Management, Pearson

REFERENCE BOOKS

1. Koontz, H., and Weihrich, H., Essentials of Management: An International Perspective, 8th ed., McGraw Hill, 2009.
2. Hicks, Management: Concepts and Applications, Cengage Learning, 2007.
3. Mahadevan, B., Operations Management, Theory and Practice, Pearson Education Asia, 2009
4. Kotler, P., Keller, K.L, Koshy, A., and Jha, M., Marketing Management, 13th ed., 2009.
5. Khan, M.Y., and Jain, P.K., Financial Management, Tata-Mcgraw Hill, 2008.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF381**
3. Course Title	**Positive Psychology and Living**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

This course provides an introduction to the science related to happiness, well-being, flourishing and the positive aspects of human experience. This course discusses research findings in the field of positive psychology. It also features practical applications of this science that you can put to use immediately to help you live a full and meaningful life.

9. Course Objectives

The purpose of this course is to provide increase awareness for relevance of positive emotions at workplace. Students will gain psychological skills to maximize happiness and virtues like compassion, love and wisdom through experiential, workshop based and interactive activities along with assigned lectures and reading. Students will have an opportunity to explore the concepts (e.g., biological, psychological, social, emotional), the research behind the concepts, and evidence-based experiential activities that enhance well-being. Students will engage in a detailed analysis and evidence-based positivity change process utilizing validated questionnaires and positive psychology and well-being enhancing interventions.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Students learn about modern psychological knowledge of happiness.
2. Students acquire skills to cultivate positive emotions.
3. Measure and build individual, workplace and educational flourishing; plan, implement and assess positive psychology.
4. Students will gain an understanding of what contributes to well-being and how to build the enabling conditions of a life worth living.

11. Curriculum Content

Unit 1: What is positive psychology?

Introducing Positive Psychology: Definition, goals, assumptions, key concepts and relationships with health psychology, developmental psychology, social psychology and psychology of religion, Meaning and measure of Happiness: Hedonic and Eudemonic perspective, Yogic notion of bliss

Unit 2: Positive Emotions, Cognitive states and Well-being

What are positive emotions? The broaden and build theory, relevance of positive emotional states for

physical, social & psychological resources, Positive emotions and well-being: Happiness and positive behavior, positive emotions and success, resilience, Self-efficacy, Optimism, Hope, Wisdom, Mindfulness and flourishing

Unit 3: How to enhance well-being?

Use of postures, breathing practices, Sounds, dietary consumption

Unit 4: Positive Psychology at work place

Maximizing achievement, conflict resolution, gratitude, positive leadership

Textbook(s)

Snyder (2011). Positive Psychology: The Scientific and Practical Explorations of Human Strengths. New Delhi: Sage.

Reference Books

1. Carr, A. (2004). Positive Psychology: The science of happiness and human strength.UK: Routledge.
2. Peterson, C. (2006). A Primer in Positive Psychology. New York: Oxford University Press.
3. Seligman, M.E.P. (2002). Authentic Happiness: Using the New Positive Psychology to Realize YourPotential for Lasting Fulfillment. New York: Free Press/Simon and Schuster.
4. Snyder, C.R., & Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage.
5. Snyder, C. R., & Lopez, S. (Eds.). (2002). Handbook of positive psychology. New York: Oxford University Press.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF382**
3. Course Title	**Engineering Economics**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

The course is devoted to teach basic concept of economics to the student of engineering. This includes basic concept of demand and supply of goods and services. Break-even point and evaluation is also included in this subject. Project evaluation and depreciation of physical assets are also key contribution in this subject. Finally, few concepts of banking system, inflation and business cycle are also the vital topics in this subject.

9. Course Objectives

- To provide the basic overview of economics in engineering perspectives.
- To increase the understanding of students to solve the engineering problems through economic theories.
- To increase the understanding of students to use economics theories in project investment of industries

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

- Students will be able to apply economic principles and calculations to solve engineering projects.
- To students will be efficient to get the idea of production activities and its applications in industries
- Students will be competent to estimate the present and future value of money on their various investment plans.
- Develop the ability to account for time value of money using engineering economy factors and formulas, as well as the implications and importance of considering taxes, depreciation, and inflation.

11. Curriculum Content

Unit 1 General Overview of Economics

Nature and Scope of Economics in engineering perspective; **Theory of Demand Analysis:** Meaning and Types, Law of demand, Exceptions to the Law of Demand, Elasticity of Demand; **Theory of Supply Analysis:** Law of Supply and Elasticity of Supply; Mathematical Explanation on cost, revenue and profit function

Unit 2 Production Function and Its Applications

Production Function: Short-run and long-run Production Function; **Mathematical Explanation:** Laws of Returns to Scale & Law of Diminishing Returns Scale; **Concept of Cost and Its Types:**

Total cost, fixed cost, variable cost, average variable cost, average fixed cost, marginal cost, explicit and implicit cost; **Break-Even-Analysis:** Importance and graphical presentation, mathematical problems

Unit 3 Time Value of Money and Project Evaluation

Time Value of Money: Simple and Compound, Uniform Series Compound Interest Formula, Present Worth Analysis, Future Worth Analysis, Future Value through Annuity, Rate of Return Analysis, Cash flow diagrams; **Depreciation**: Introduction, Straight Line and Declining Balance Method of Depreciation; **Project Evaluation Techniques:** Present Worth Method, Future Worth Method, Annual Worth Method; Benefit Cost Analysis: Conventional and Modified B/C Ratio with PW method

Unit 4 Banking and Finance

Banking Sector: Functions of the Commercial Bank and Central Bank, Financial Institutions; **Financial Market:** Money Market and Capital Market; **Monetary and Fiscal Policy:** Objectives, Instruments, Tools in Indian Economy; **Inflation:**Causes, Effects and Methods to Control it, Measurement of Inflation- Consumer Price Index and Whole Price Index; Deflation and Stagflation; **Business Cycles:** Various phases, Control and Measurement, Impact on business cycles on economic activities

TEXT BOOKS TEXT BOOKS

1. Pravin Kumar (2015). Fundamental of Engineering Economics. Raj Kamal Press, New Delhi.
2. Riggs J.L., Dedworth, Bedworth D.B., and Randhawa, S.U. (1996). Engineering Economics. McGraw Hill International, New Delhi
3. PanneerSelvam R. (2001). Engineering Economics. Prentice Hall of India Ltd, New Delhi.

REFERENCE BOOK

1. L.M. Bhole (2007). Financial Institutions and Markets. Tata McGraw Hill, New Delhi.

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF481**
3. Course Title	**Application of Psychology**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

This course will introduce students about knowledge in the various domains of psychology and its applications. It also includes theories of self, work motivation, job satisfaction, attitude and stress and its management.

9. Course Objectives

The purpose of this course is to develop a broad base of knowledge in the various domains of psychology and its applications. This course is also about to synthesis and demonstrates of useful skills in the field of psychology namely areas of organization, society, stress management etc.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

a. The students will be able to understand basic concepts of psychology in major domains.
b. The students will be able to apply the fundamentals of psychology in order to solve real life problems.
c. The students will Use scientific reasoning to interpret psychological phenomena.
d. To apply ethical standards to evaluate psychological science and practice

11. Curriculum Content

Unit 1: Role of Psychology in Understanding the Self

Three Stages – Self-awareness, Self-acceptance and Self-realization; Exploration through JOHARI Window; Development of Self-Mead & Cooley

Unit 2: Application of Psychology at Work Place

Work Motivation: Theories and applications: Maslow, Herzberg, Goal Setting, Emotion: Emotional Quotient & Job Satisfaction, Early approaches to leadership, contemporary approaches to leadership-Transformational & Transactional Leadership, styles of leadership

Unit 3: Application of Psychology in Personal & Professional Excellence

Achieving Success: Creativity & Innovation; Role of attitude; Role of competence; Role of Self-confidence; Time management; Role of Human Values.

Unit 4: Role of Psychology in Health & Fitness

Stress & Coping Strategies: Meaning, Types, Sources, Effects of stress on health, and coping strategies; Characteristics of a healthy personality

Textbook(s)

1. R. Bayne, and I. Horton, Applied Psychology, Sage publications, 2003.
2. A. Furnham, The Psychology of Behaviour at Work, Psychology Press, 1997.
3. D. Harris, Engineering Psychology and Cognitive Ergonomics, Aldershot: Ashgate, 1997

Reference Books

1. Baron, R.A. and Misra, G., Psychology (Indian Subcontinent Edition). Person Education Ltd. (2014).
2. Ciccarelli, S.K. & Meyer, G.E., Psychology (South Asian Edition). New Delhi: Tata Mc Graw Hill. (2008).
3. Passer, M.W., Smith, R.E., Holt, N. and Bremmer, A., Psychology: The Science of Mind and Behavior, McGraw-Hill Education, UK. (2008).
4. R. Gifford, (Ed.), Applied psychology: Variety and opportunity, Allyn and Bacon, 1991.
5. M.L. Blum, and J.C. Naylor, Industrial Psychology, CBS Publishers & Distributors, 1984.
6. D.M. Pestonjee, Stress and Coping: The Indian Experience, 2nd ed., Sage Publications, 1999.

13. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1. Department offering the course	**Humanities & Liberal Arts**
2. Course Code	**LAF482**
3. Course Title	**Intellectual Property Rights**
4. Credits (L:T:P:C)	**3:0:0:3**
5. Contact Hours (L:T:P)	**3:0:0**
6. Prerequisites (if any)	**NIL**
7. Course Basket	**Humanities & Liberal Arts**

8. Course Summary

The course offers a comprehensive intellectual property subject that is easy to understand for students. The intellectual property rights syllabus comprises topics ranging from patent registration to copyrights and trademarks, and examples are based on familiar situations that the students encounter in their day-to-day lives. Topics would include the major aspects of IPR, which include analysing an idea, patent search techniques, which also helps them to boost their career with additional industry-relevant skills.

9. Course Objectives

The purpose of this course is to provide the basic understanding of intellectual property rights, the rationale behind making provision for these rights and the recent concerns in the field. The main objective of the course is to increase the attention of students to protect their IP though legal provision and also teach the students how they can reduce the imitation rate. This course also helps to teach the students the understanding their involvement in technology transfer and commercialization.

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. The students will be able to understand the importance of IPRs in academic field.
2. The student gets idea how they can protect their IP through IPRs regime.
3. The student gets more incentive towards technology transfer and commercialization
4. Apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyse the social impact of intellectual property law and policy

11. Curriculum Content

Unit 1: Introduction to IP

Public Funded Research and Its Implications in an Economy; Public Funded Research and Economic Development; Research & Development and Industrial Development

Unit 2: Historical Perspectives of IPRs

History and concept of Property; Introduction to intellectual property rights (IPRs); Patent, Industrial design; Copyrights, Trademarks, Geographical Indications; Trade Secrets; International aspect of IPRs; Development at International level regarding IPRs

Unit 3: Polices on IPRs in India

The debate: Copyright vs Copy left; Research ethics; role of IPRs in economic development in developed and developing economies; Overview of Various Policies on IPRs in India; Success Story of Bayh Dole Act of IPRs in USA

Unit 4: IPRs and Technology Commercialization

Technology Transfer and Commercialization; Key Determinants and Participants of Technology Transfer and Commercialization; Types of Technology Transfer and Commercialization; Technology Transfer and Commercialization in India and Other Developing Economies

Textbook(s)

1. Cornish, W.R. and L. David. 2010. 7th Edition. Intellectual Property: Patents, Copyrights, Trademarks and Allied Rights. Sweet and Maxwell.
2. Narayan, P. 2002. Intellectual Property, Law in India, 3rd Ed. New Delhi, Delhi Law House.
3. Ganguli, P. 2001. Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw Hills.
4. Watal, J. 2001. Intellectual Property Rights in the WTO and Developing Countries. New Delhi: Oxford University Press.

Reference Books

1. Singh A.K., Ashraf S.N. and Acharya S.R. 2017. Viability of Bayh Dole Act of USA in the context of India: Critical evidence from review of literature, in Sasi Misra.
2. Sunil Shukla and GanapathiBatthini (Eds). Proceedings of the 12th Biennial Conference on Entrepreneurship Organized by EDII Ahmedabad (pp. 235-252). Bookwell Publishing House: New Delhi

12. Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle. Refer to your course in Moodle for details.

1.	**Department offering the course**	**Humanities & Liberal Arts**
2.	**Course Code**	**LAF285**
3.	**Course Title**	**Indian Constitution**
4.	**Credits (L:T:P:C)**	**2:0:0:2**
5.	**Contact Hours (L:T:P)**	**2:0:0**
6.	**Prerequisites (if any)**	**NIL**
7.	**Course Basket**	**AEC**

8. Course Summary:

The Constitution of India is the supreme law of India. The document lays down the framework demarcating fundamental political code, structure, procedures, powers, and duties of government institutions and sets out fundamental rights, directive principles, and the duties of citizens. The course will provide knowledge of their constitutional rights to the students and also familiarize the students with the features of the Indian Constitution.

9. COURSE OBJECTIVE:

- To familiarize the students with the features of the Indian Constitution
- To provide a knowledge of their constitutional rights

10. Course Outcomes

On successful completion of the course, students will be able to achieve the following:

- Enable the students to protect their rights
- The students will be engaged in the political system of India

11. Curriculum Content

Unit 1: Introduction

Constitution- meaning of the term, basic features Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive, Principles of State Policy, debates on Fundamental Rights and Directive

Unit 2: Union Government and its Administration

Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha Institutional Functioning: Prime Minister, Parliament and Judiciary, Power Structure in India: Caste, class and patriarchy

Unit 3: State Government and its Administration

Governor: Role and Position, CM and Council of ministers, State Secretariat: Organisation, Structure and Functions.

Unit-4 Local Administration

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected, Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit 5: Election Commission

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

TEXT BOOKS

1. Abbas, H., Kumar, R. & Alam, M. A. (2011) Indian Government and Politics. New Delhi: Pearson, 2011.
2. Chandhoke, N. & Priyadarshi, P. (eds.) (2009) Contemporary India: Economy, Society, Politics. New Delhi: Pearson.

REFERENCE BOOKS

1. Chakravarty, B. & Pandey, K. P. (2006) Indian Government and Politics. New Delhi: Sage.
2. Chandra, B., Mukherjee, A. & Mukherjee, M. (2010) India After Independence. New Delhi: Penguin.
3. Singh, M.P. & Saxena, R. (2008) Indian Politics: Contemporary Issues and Concerns. New Delhi: PHI Learning.
4. Vanaik, A. & Bhargava, R. (eds.) (2010) Understanding Contemporary India: Critical Perspectives. New Delhi: Orient Blackswan.

12 Teaching and Learning Strategy

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