

COURSE OF STUDY
B.Tech. First Year-2019 batch



National Institute of Technology Srinagar

National Institute of Technology

1st Semester (Group A)

Electrical / Electronics & Comm. / Computer Science / Information Technology

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	EEL100	Basic Electrical Engineering	Electrical	4	3	1	0	4
2	HUL100	Basic English and Communication Skills	Humanities	3	2	1	0	3
3	ITL100	Computer Programming	Information Technology	3	2	1	0	3
4	CYL100	Engineering Chemistry	Chemistry	4	3	1	0	4
5	CIP100	Engineering Drawing	Civil	4	1	0	6	7
6	MAL100	Mathematics I	Mathematics	4	3	1	0	4
7	ELP100	Basic Electrical Engineering Laboratory	Electrical	1	0	0	2	2
8	CYP100	Chemistry Laboratory	Chemistry	1	0	0	2	2
9	ITP100	Computer Programming Laboratory	Information Technology	1	0	0	2	2
		Total		25	14	5	12	31

1st Semester (Group B)

Civil/ Mechanical / Chemical / Mett & Mat Science

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	MEL100	Elements of Mechanical Engg.	Mechanical	3	2	1	0	3
2	PHL100	Engineering Physics	Physics	4	3	1	0	4
3	CIL100	Engineering Mechanics	Civil	4	3	1	0	4
4	HUL100	Basic English and Communication Skills	Humanities	3	2	1	0	3
5	CYL101	Environmental Studies	Chemistry	3	2	1	0	3
6	MAL100	Mathematics I	Mathematics	4	3	1	0	4
7	HUP100	Language Laboratory	Humanities	1	0	0	2	2
8	PHP100	Physics Laboratory	Physics	1	0	0	2	2
9	WSP100	Work shop Practice	Work shop	2	0	0	5	5
		Total		25	15	6	9	30

National Institute of Technology

2nd Semester (Group A)

Electrical / Electronics & Comm. / Computer Science / Information Technology

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	HUL101	Advanced English Comm. Skills & Organizational Behavior	Humanities	3	2	1	0	3
2	PHL100	Engineering Physics	Physics	4	3	1	0	4
3	CIL100	Engineering Mechanics	Civil	4	3	1	0	4
4	MEL100	Elements of Mechanical Engg.	Mechanical	3	2	1	0	3
5	CYL101	Environmental Studies	Chemistry	3	2	1	0	3
6	MAL101	Mathematics II	Mathematics	4	3	1	0	4
7	HUP100	Language Laboratory	Humanities	1	0	0	2	2
8	PHP100	Physics Laboratory	Physics	1	0	0	2	2
9	WSP100	Work shop Practice	Work shop	2	0	0	5	5
		Total		25	15	6	8	30

2nd Semester (Group B)

Civil/ Mechanical / Chemical / Mett & Mat Science

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	HUL101	Advanced English Comm. Skills & Organizational Behavior	Humanities	3	2	1	0	3
2	EEL100	Basic Electrical Engineering	Electrical	4	3	1	0	4
3	ITL100	Computer Programming	Information Technology	3	2	1	0	3
4	CYL100	Engineering Chemistry	Chemistry	4	3	1	0	4
5	CIP100	Engineering Drawing	Civil	4	1	0	6	7
6	MAL101	Mathematics II	Mathematics	4	3	1	0	4
7	ELP100	Basic Electrical Engineering Laboratory	Electrical	1	0	0	2	2
8	CYP100	Chemistry Laboratory	Chemistry	1	0	0	2	2
9	ITP100	Computer Programming Laboratory	Information Technology	1	0	0	2	2
		Total		25	14	5	12	31



DEPARTMENT OF ELECTRICAL ENGINEERING NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Basic Electrical Engineering (ELE-301)	Syllabus for B.Tech:- 1stYear(1stSem) ELE/ECE/CSE/IT		Total CourseCredit:4		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective: To acquaint the students with the behavior of electric circuits with different excitations and to learn different techniques of AC and DC circuit analysis.

Course Outcomes (COs) : Upon successful completion of the course , student should be able to:

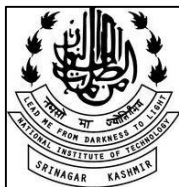
- CO1:** Analyze the behavior of different electric circuit parameters and have a thorough understanding of different types of energy sources.
- CO2:** Analyze the different configurations of DC circuits using basic circuit laws like KVL, KCL and tools like mesh analysis and nodal analysis.
- CO3:** Apply network analysis theorems like Superposition theorem, Thevenin's theorem, Norton's theorem and Maximum Power Transfer theorem to DC circuits and networks.
- CO4:** Use phasor representation for steady state analysis of sinusoidally excited AC circuits and apply different network techniques for their analysis.
- CO5:** Understand the concept of active, reactive power and power factor correction in AC circuits.
- CO6:** Analyze various configurations of 3-phase AC circuits.

UNIT-I	<p>Basic Concepts and Electric Circuit Parameters:</p> <p>Review of electric circuit concepts, terminology, basic laws, and electric circuit parameters.</p> <p>ENERGY SOURCES: Ideal and practical voltage and current sources and their transformation, Independent and dependent sources.</p>
UNIT-II	<p>D.C. Circuit Analysis:</p> <p>Power and energy relations, Analysis of series parallel D.C. Circuits, Loop and nodal methods of analysis, Delta-star(Δ-Y) transformation, Superposition theorem, Thevenin's and Norton's theorems, Maximum power transfer theorem.</p>

UNIT-III	Sinusoidal Steady State Analysis of AC Circuits: Basic terminology and definitions, Phasor and complex number representation solutions of sinusoidally excited AC circuits, Power and energy relations in A.C. circuits, Applications of network theorems to A.C. circuits, Resonance in series and parallel circuits.
UNIT-IV	AC Power Analysis Power and energy relations in AC circuits, Instantaneous power and apparent power, Average power, Concept of power factor, Active and reactive power, Complex power, Maximum power transfer theorem, Power factor corrections.
UNIT-V	Steady State Three- Phase AC Circuits: Characteristics of 3 phase systems, Current and voltage relationships in Δ -Y & Y- Δ configurations, Balanced / un-balanced systems.

Books Recommended:

Text Books	<ol style="list-style-type: none"> 1. Alexander & Sadiku: Fundamentals of Electric Circuits, 6th Edition McGraw Hill Education. 2. Irwin & Nelms: Basic Engineering Circuit Analysis, 7th Edition, John Wiley and Sons Ltd. 3. Vincent Del Toro: Electric Engineering Fundamentals, 2nd Edition, Pearson Education India.
Reference Books	<ol style="list-style-type: none"> 4. Sergio Franco: Electric Circuit Fundamentals, Oxford University Press 5. Johnson & Hilburn: Basic Electric Circuit Analysis, 5th Edition, John Wiley & Sons Ltd. 6. Hayt & Kimmerly: Engineering Circuit Analysis, 8th Edition, McGraw Hill Education.



DEPARTMENT OF ELECTRICAL ENGINEERING NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Basic Electrical Engineering (ELE-301)	Syllabus for B.Tech: 1stYear(2ndSem) CIV/MECH/MET/CHEM		Total CourseCredit:4		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective: To acquaint the students with the behavior of electric circuits with different excitations and to learn different techniques of AC and DC circuit analysis.

Course Outcomes (COs) : Upon successful completion of the course , student should be able to:

- CO1:** Analyze the behavior of different electric circuit parameters and have a thorough understanding of different types of energy sources.
- CO2:** Analyze the different configurations of DC circuits using basic circuit laws like KVL, KCL and tools like mesh analysis and nodal analysis.
- CO3:** Apply network analysis theorems like Superposition theorem, Thevenin's theorem, Norton's theorem and Maximum Power Transfer theorem to DC circuits and networks.
- CO4:** Use phasor representation for steady state analysis of sinusoidally excited AC circuits and apply different network techniques for their analysis.
- CO5:** Understand the concept of active, reactive power and power factor correction in AC circuits.
- CO6:** Understand the working and application of DC and AC electric machines, and transformers.

UNIT-I	<p>Basic Concepts and Electric Circuit Parameters</p> <p>Review of electric circuit concepts, terminology, basic laws, and electric circuit parameters.</p> <p>ENERGY SOURCES: Ideal and practical voltage and current sources and their transformation, Independent and dependent sources.</p>
UNIT-II	<p>D.C. Circuit Analysis:</p> <p>Power and energy relations, Analysis of series parallel D.C. Circuits, Loop and nodal methods of analysis, Delta-star(Δ-Y) transformation, Superposition theorem, Thevenin's and Norton's theorems, Maximum power transfer theorem.</p>

UNIT-III	<p>Sinusoidal Steady State Analysis of AC Circuits:</p> <p>Basic terminology and definitions, Phasor and complex number representation solutions of sinusoidally excited AC circuits, Power and energy relations in A.C. circuits, Applications of network theorems to A.C. circuits, Resonance in series and parallel circuits.</p>
UNIT-IV	<p>AC Power Analysis</p> <p>Power and energy relations in AC circuits, Instantaneous power and apparent power, Average power, Concept of power factor, Active and reactive power, Complex power, Maximum power transfer theorem, Power factor corrections.</p>
UNIT-V	<p>Electric Machines and Transformers:</p> <p>Principle of operation, Construction and working of i) DC machines ii) AC machines iii) Single phase transformers.</p>

Books Recommended:

Text Books	<ol style="list-style-type: none"> 1. Alexander & Sadiku: Fundamentals of Electric Circuits, 6th Edition McGraw Hill Education. 2. Irwin & Nelms: Basic Engineering Circuit Analysis, 7th Edition, John Wiley and Sons Ltd. 3. Vincent Del Toro: Electric Engineering Fundamentals, 2nd Edition, Pearson Education India 4. Nagarath, I.J & Kothari: Electric Machines, 4th Edition, Tata McGraw-Hill Company
Reference Books	<ol style="list-style-type: none"> 5. Sergio Franco: Electric Circuit Fundamentals, Oxford University Press 6. Johnson & Hilburn: Basic Electric Circuit Analysis, 5th Edition, John Wiley & Sons Ltd. 7. Vincent Del Toro: Basic Electric Machines, Prentice Hall.

Course for B. Tech Semester 1

Course Title: Basic English and Communication Skills

Course Code: HUL 100

Credit Hours: 03

Programme: B. Tech Semester 1

Course Description: The course is designed to develop basic reading, writing, speaking, and listening skills of the students. It is organized in a manner that the reading, vocabulary, grammar, and writing exercises are interconnected, contextual as well as non-contextual. It helps them to learn effective reading techniques enabling them to identify main ideas and to glean details from a text. The course facilitates an understanding of word structure and thereby enrichment in vocabulary. It also assists the students to acquire knowledge on formal writing skills. The presentation skills taught through the course intends to enhance the expressive skills of the students such that they are able to express their feelings, thoughts, and expressions effectively to the listeners.

Course Objectives: The course intends to help the students do the following:

1. Learn the techniques of effective reading and good comprehension.
2. Develop an understanding of word structure and word formation.
3. Enrich their vocabulary by learning antonyms, synonyms and the meaning and applications of words pertaining to various parts of speech.
4. Use grammatical elements such as articles, prepositions, tenses, modifiers and noun-pronoun and subject-verb agreement correctly.
5. Learn the structure and style of sentences and paragraphs.
6. Study the nature and style of formal letters.
7. Learn the nature and style of formal writing.
8. Focus on the sound system in English and learn correct pronunciation.
9. Focus and learn stress, rhythm, and intonation in English.
10. Develop their presentation skills.

Syllabus Components:

Unit 1: Reading and Comprehension Skills - I

1. Importance and techniques of effective reading
Essay 1: The Raman Effect + Supplementary Reading Passages
2. Improving Comprehension skills, techniques for good comprehension
Essay 2: Ancient Architecture in India + Supplementary Reading Passages
3. Skimming and scanning
Essay 3: Blue Jeans + Supplementary Reading Passages

Unit 2: Vocabulary - I

1. Word formation, use of prefixes and suffixes
2. Synonyms and antonyms
3. Prefixes and Suffixes from foreign languages, words from foreign languages

Unit 3: Grammar

1. Articles and Prepositions
2. Noun-pronoun agreement and subject-verb agreement
3. Tenses and Misplaced modifiers

Unit 4: Formal Writing Skills

1. Sentences and Paragraphs: Sentence structures, phrases and clauses, techniques for writing precisely, paragraph writing, organising principles of paragraphs in documents
2. Letter writing: Formal letters, letter of complaint, requisition letter
3. Formal writing: Nature and style of formal writing; Use of topic sentences and thesis statements.

Unit 5: Basic Presentation and Speaking Skills

An overview of the sound system in English: Vowels and Consonants
IPA (International Phonetic Alphabet) symbols
Pronunciation (Activities based on audio tapes)
Stress, Rhythm, Intonation
Accent: British English and American English
Presentation Skills

Course Outcomes: Upon completion of this course the student will have reliably demonstrated basic reading, writing, listening, and speaking abilities.

CO1. Given an academic reading passage the student will be able to:

1. Identify the main idea(s) in the text
2. Identify specific details

CO2. Given questions on vocabulary, the students will be able to:

1. Form words using prefixes and suffixes
2. Define and use antonyms and synonyms
3. Define and use words of foreign origin
4. Demonstrate a significant increase in word knowledge

CO3. Given questions on grammar, the student will be able to:

1. Produce accurate grammatical forms of articles and prepositions
2. Recognize and incorporate proper grammatical forms of verb tense, modifiers, noun-pronoun and subject-verb agreement.

CO4. Given a writing prompt, the student will be able to:

1. Use a variety of accurate sentence structures
2. Write a paragraph with a topic sentence, supporting and concluding sentence
3. Produce coherent and unified paragraphs
4. Write a thesis statement that addresses the writing prompt
5. Write formal letters

CO5. Given questions on English phonetics and presentation prompts, the student will be able to:

1. Demonstrate phonemic awareness
2. Recognize all vowel and consonant sounds in spoken English through the help of IPA (International Phonetic Alphabet) symbols
3. Perceive and generate syllable stress within words and word stress within phrases
4. Identify stressed and unstressed syllables in multi-syllabic words
5. Detect rhythm in phrases and sentences
6. Employ the rules and patterns of intonation

7. Exhibit British and American Accent
8. Given a topic to present, the student will be able to give an oral presentation in class using effective delivery strategies

Reference Books:

1. *English for Engineers*. By N. P. Sudharshana and C. Savitha. Cambridge University Press, 2018.
2. *Oxford Guide to Effective Writing and Speaking Skills*. By John Seely. Oxford University Press, Indian Edition, 2008.
3. *Professional Speaking Skills*. By ArunaKoneru. Oxford University Press, 2015.
4. *Intermediate English Grammar: Reference and Practice for South Asian Students*. By Raymond Murphy. Cambridge University Press, 1994.

Syllabus for B. Tech Semester 2

Course Title: Advanced English Communication Skills and Organizational Behaviour

Course Code: HUL 101

Credit Hours: 03

Programme: B. Tech Semester 2

Course Description: The course is designed to augment the reading, writing, and speaking skills of the students. It graduates from the basic level course offered in the previous semester to an advanced level. The reading, vocabulary, grammar, and writing exercises are interconnected, contextual as well as non-contextual. It also intends to teach them the norms of academic and research writing along with job-application and project proposal writing. It trains the students to speak grammatically correct English fluently and confidently in everyday as well as professional situations such as group discussions and job interviews. The course also enable the students to understand the concept of organization, organizational structure, and organizational behavior and its relevance in today's business environment. Students will be acquainted with the concepts of motivation and leadership.

Course Objectives: The course aims to help the students do the following:

1. Improve reading comprehension skills through intensive and extensive reading
2. Summarize and paraphrase information in a text
3. Identify author's purpose and tone
4. Recognize and rectify common errors in grammar
5. Use punctuation to the best purpose
6. Make use of modals and active and passive voice appropriately
7. Learn the norms of academic and research writing
8. Learn the steps in report writing, along with the types and outline of reports
9. Get acquainted with the APA and MLA referencing styles
10. Familiarize with the standards of email writing
11. Get accustomed with the structure of job cover letters
12. Learn the structure and contents of résumé
13. Learn the essentials of successful project proposal
14. Speak grammatically correct English fluently and confidently in everyday as well as professional situations
15. Understand the basic concept of organisation, its need importance and process.
16. Know the organisational structure and different types of organisations
17. Understand the relevance of organizational behaviour in today's business world.
18. Gain knowledge about various theories of motivation and leadership in an organisation.

Syllabus Components:

Unit 1: Advanced Reading and Comprehension Skills

1. Intensive and extensive reading
Essay 1: What Should You Be Eating?+ Supplementary Reading Passages
2. Improving Comprehension skills, techniques for good comprehension
Essay 2: How a Chinese Billionaire Build Her Fortune + Supplementary Reading Passages

Unit 2: Grammar

1. Common errors in Grammar
2. Punctuation

3. Use of modals
4. Active and Passive Voice

Unit 3: Academic and research writing skills

1. Introduction to Academic and Research writing.
2. Precautions in Academic and research writing.
3. Report writing: Steps in report writing; Types of reports, business and technical reports.
4. Referencing styles (APA and MLA Styles)

Unit 4: Successful job-application and project-proposal writing

1. Professional email writing.
2. Structure and content of Job Cover letters.
3. Structure and contents of Résumé.
4. Essentials of a successful project proposal.

Unit 5: Advanced Presentation and Speaking Skills

1. Body Language and Barriers to Communication
2. Greetings, Introductions, Small Talks
3. Expressing Opinions, Agreement and Disagreement.
4. Group discussions and job interviews.

Unit 6: Organization

1. Organization: Introduction, definition, need and importance, principles and process of organizing
2. Organizational structure and its types, span of control, authority, Centralization and decentralization of authority.

Unit 7: Organizational Behavior

1. Organizational Behavior: Introduction, definition, goals and importance of OB, approaches to OB and its relevance in today's Business Environment.
2. Meaning and Concept of Motivation, Types and theories of Motivation, Personality, Leadership and Interpersonal Skills.

Course Outcomes: Upon completion of this course the student will have reliably demonstrated basic reading, writing, listening, and speaking abilities.

CO1. Given an academic reading passage, the student will be able to:

1. Distinguish main idea(s) from supporting details and distinguish fact from opinion
2. Identify author's purpose and tone
3. Summarize and paraphrase information in a text

CO2. Given questions on grammar, the student will be able to

1. Recognize and rectify common errors in grammar
2. Use punctuation to the best purpose
3. Use modals correctly
4. Identify active and passive voice in sentences and transform a sentence in one voice into another

CO3. Given a writing prompt, the student will be able to:

1. Produce an academic research essay

2. Write a formal report
3. Write bibliography accurately as per the APA and MLA styles of referencing

CO4. Given a writing prompt, the student will be able to:

1. Write a professional email
2. Write a job cover letter
3. Write a résumé with its essential elements
4. Write a project proposal with its essential elements.

CO5. Given directions to communicate orally, the student will be able to:

1. Greet others, introduce him/herself, and initiate small talks fluently and confidently.
2. Express opinions and effectively show agreement and disagreement with the opinions of others
3. Participate and be sufficiently understood in group discussions
4. Prepare for interviews by demonstrating learning and verbal and non-verbal communication skills during mock interviews.

CO6. The students will be able to:

1. Define and explain the term organisation, and its need
2. Discuss importance and steps involved in organisation
3. Describe organisational structure and various types of organisation

CO7. The students will be able to:

1. Demonstrate the relevance of organisational behaviour in today's business environment with different theories of Organizational Behaviour.

Reference Books:

1. *English for Engineers*. By N. P. Sudharshana and C. Savitha. Cambridge University Press, 2018.
2. *Oxford Guide to Effective Writing and Speaking Skills*. By John Seely. Oxford University Press, Indian Edition, 2008.
3. *Professional Speaking Skills*. By Aruna Koneru. Oxford University Press, 2015.
4. *Intermediate English Grammar: Reference and Practice for South Asian Students*. By Raymond Murphy. Cambridge University Press, 1994.
5. *Organisational Behaviour*. By Robins. Prentice Hall.
6. *Organisational behaviour*. By Fred Luthans. McGraw Hill
7. *Leadership for Engineers: The Magic Mindset*. By George Runcie. McGraw Hill Higher Education.

Books for supplementary readings:

1. Robins. P. S, Judge. A. T and Vohra. N, 2017 "Organisational Behaviour", Pearson. Rs. 500
2. Khanka. S. S, 2006 "Organisational Behaviour" S Chand Rs. 499
3. Sing. C and Khatri. A, 2016, "Principle and practices of management and Organisational Behaviour" Rs. 450
4. Northhouse. G. P, 2014, "Leadership: Theory and Practices", Sage Publications India Ltd Rs.509

Language Lab Course (HUP100)

The course is designed for students who need to develop better listening, speaking, and presentation skills in English language. This course is specifically targeted towards those students for whom English is not their first language. Audio-video interaction and exercises based on language lab software will improve listening and pronunciation skills of the students such that they will be able to interpret and replicate what they hear in English. The course instructor will encourage and help students to speak grammatically correct English with fluency and confidence. The presentation skills taught through the course intends to enhance the expressive skills of the students such that they are able to express their feelings, thoughts, and expressions effectively to the listeners.

Course Objectives: The course intends to help the students do the following:

11. Learn and use the sound system in English and learn and use correct pronunciation.
12. Learn and use stress, rhythm, intonation, British and American English.
13. Develop an understanding of word structure and word formation.
14. Speak grammatically correct English fluently and confidently in everyday as well as professional situations
15. Develop their presentation skills.

Syllabus Components

Unit 1: Speaking, Listening, and Pronunciation

Phonetics: An overview of the sound system in English: Vowels and Consonants
Listening Comprehension
Syllable Structure and Syllable Break-up
Pronunciation
Stress, Rhythm, Intonation
Accent: British English and American English

Unit 2: Communication and Presentation Skills

Situational Dialogues, Role Play
Self introduction and Introducing others
Greetings, Expressing opinion, agreement and disagreement
Practice in Group Discussions, Interview Practices, Presentation Skills

Course Outcomes:

Upon successful completion of this course the student will reliably demonstrate basic listening, speaking, and presentation abilities.

CO1. Given prompts and questions on English phonetics, the student will be able to:

9. Demonstrate phonemic awareness
10. Recognize all vowel and consonant sounds in spoken English
11. Answer questions based on audio recordings of native speakers of English.
12. Perceive and generate syllable stress within words and word stress within phrases
13. Identify stressed and unstressed syllables in multi-syllabic words
14. Detect rhythm in phrases and sentences
15. Employ the rules and patterns of intonation
16. Exhibit British and American Accent

CO2. Given directions to communicate orally, the student will be able to:

5. Greet others, introduce him/herself, and initiate small talks fluently and confidently.
6. Express opinions and effectively show agreement and disagreement with the opinions of others
7. Participate and be sufficiently understood in group discussions
8. Prepare for interviews by demonstrating learning and verbal and non-verbal communication skills during mock interviews.
9. Give an oral presentation in class using effective delivery strategies

Suggested Readings:

1. *Professional Speaking Skills*. By ArunaKoneru. Oxford University Press, 2015.
2. *Oxford Guide to Effective Writing and Speaking Skills*. By John Seely. Oxford University Press, Indian Edition, 2008.
3. *Developing Communication Skills*. 2nd Edition. By Krishna Mohan and MeenaBanerji. Published by Macmillan, 1990, 2009.
4. *Effective Business Communication*. 7th Edition-Special Indian Edition. By Herta A Murphy, Herbert W Hildebrandt, Jane P Thomas. Published by McGraw Hill Education. 1997, 2018.

Web and Software Resources:

1. Lessons and Exercises based on Words Worth English Language Lab Software
2. Lessons and Exercises based on British Council English Learning web resources

Subject : Computer Programming
Semester : 1st
Department : Information Technology
Course No. : ITL 100
Credits : 3
L T P : 3 0 0

Course Outcomes:

CO1	To provide exposure to problem solving through programming.
CO2	To understand the Syntax and Semantics of the 'C' language.
CO3	To understand the basics of programming including the most common library functions and the usage of the pre-processor.
CO4	To understand the concept of loops and to learn how to write a program in C using loops.
CO5	To understand the data types offered by the C language including complex data types: arrays, structures and pointers.
CO6	To understand the concept of strings in programming.
CO7	To understand the concept of file handling in programming.

Course Details:

Introduction to C Programming: Engineering problem solving methodology, Flow charts, Tracing flow charts, Algorithms, Need for computer Languages, computer languages, High-level languages, History of C, A simple C Program.

C Language preliminaries: Program structure, C character set, Identifiers and keywords, Data types, Declarations, Expressions, statements symbolic constants, Library functions, preprocessors, # include, #define

Input-Output: getchar, putchar, scanf, printf, gets, puts and other related input output functions.

Operators and expressions: operators in C, arithmetic ,unary, logical, bit-wise, assignment and conditional operators.

Control statements: if else, switch, break, Continue, and goto statements, While, do-while, for statements, nested loops, loops using goto. comma operators and variants of above control structure.

Functions: Defining and accessing, passing arguments, Function prototypes, Recursion, Library functions, Static functions

Arrays: Defining and processing, Passing arrays to a function, matrices as 2D arrays, Multi dimensional arrays.

Pointers: Declarations, Passing pointers to a function, Operations on pointers, Pointer Arithmetic, Pointers and arrays, Arrays of pointers and function pointers. Dynamic memory allocation of arrays and higher dimensional arrays using malloc() function.

Strings Fundamentals: of character and strings, string handling library functions, pointer to strings, dynamic allocation for strings.

Structures and Unions:Defining and accessing structure, structure as function arguments, array of structures, pointers to structures, defining and accessing union.

File Handling:Files, ascii files , binary files,File operation such as storing , retrieving and updating a file.

Text Books:

1. Schaums outline of Theory and Problems of programming with C: Gottfried
2. Mastering C by Venugopal, Prasad – TMH
3. Programming in ANSI C, Balaguruswamy
4. C How to Program, P. J. Deitel and H. Deitel

Other Books Recommended:

1. Complete reference with C Tata McGraw Hill
2. Engineering Problem Solving with ANSI C, Delores M. Etter, Prentice Hall
3. C Programming, Ivor Horton, Wrox Press Limited
4. The C programming language :Kerninghan and Ritchie

Subject : Computer Programming Lab Semester : 1st Department : Information Technology Course No. : ITP100 Credits : 1 L T P : 0 0 2
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Course Outcomes:

CO1	To provide exposure to problem solving through programming.
CO2	To understand the concept of various tools available in C and to learn how to solve the problems using the code.
CO3	To understand the basics of programming including the most common library functions.
CO4	To learn how to write a program in C using loops, functions, pointers etc.

Lab Details:

1. Programs to understand how integers, characters, and strings are stored and represented in C.
2. Programs to understand the ASCII character encoding.
3. Programs to understand how to use different operators available in C.
4. Programs to understand differences between a logical and arithmetic operators.
5. Programs to understand differences between a logical and bitwise operators.
6. Programs to obtain a full understanding of signed, unsigned, long and short numbers in C.
7. Programs to understand exactly how numbers are represented in computers(octal,hexadecimal and binary numbers systems) .
8. Programs to evaluate algebraic expressions in C.
9. Programs to understand printing of various data types using different output functions.
10. Programs to exercise all flags in printf() functions.
11. Programs to understand printing of display patterns of numbers and asterisks.
12. Programs to understand taking input from user using different input functions.
13. Programs to exercise all flags in scanf() functions.
14. Programs to understand how arrays work in C, how to use them, and how they are stored in memory.
15. Programs to understand searching in an array.
16. Programs to understand sorting techniques using arrays.

17. Programs to understand pointers in C.
18. Programs to understand the relationship between array indexing and pointer arithmetic.
19. Programs to understand dynamic memory allocation especially with respect to 1D and 2D arrays.
20. Programs to understand modularize of code using functions.
21. Programs to implement function with/without arguments and with/without return types.
22. Programs to understand direct and indirect recursions using functions.
23. Programs to use pointer to pass the address of data and arrays to functions.
24. Programs to understand static data types and static functions.
25. Programs to understand creating, accessing and using structures.
26. Programs to understand use of arrays of structures.
27. Programs to understand pointers to structures and pointers as structures members.
28. Programs to understand creating, accessing and using unions.
29. Programs to understand creating, reading, writing a file.
30. Programs to understand taking input through arguments to main() function.



DEPARTMENT OF MATHEMATICS
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Mathematics-I (Code-MAL-100)	Syllabus for B.Tech.-1stSemester Common for all branches		Total Course Credit:4		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective: To Acquire basic knowledge of Differential Calculus , Ordinary differential equations and apply them to various Engineering problems.

Course Outcomes (COs):

CO1: Able to apply Leibnitz theorem and Taylor’s theorem.

CO2: Able to find Tangents and normals, Partial differentiation, Euler’s theorem, Double points, Asymptotes, Curvature and their applications.

CO3: Able to use the concepts of Limits, Continuity and differentiability functions of several variables, extrema of functions of two or more variables and their applications.

CO4: Able to solve ordinary differential equations by different methods and their applications.

CO5: Able to apply various methods for solving Cubic and Biquadratic algebraic equations.

UNIT-I	<p>Differential Calculus: (20Hrs) Leibnitz Theorem, Taylor’s Theorem, Tangent and normal, Partial differentiation, Euler’s Theorem , Double points, Asymptotes, Curvature and tracing of Curves. Limits, Continuity and differentiability of functions of two variables, extrema of functions of two or more variables using method of Lagrange’s multipliers.</p>
UNIT-II	<p>Ordinary Differential Equations: (15Hrs) Exact differential equations, Reducible to exact differential equations, Linear differential equations and equations reducible to linear form, Nonlinear differential equation, Linear differential equations of second and higher order with constant and variable coefficients, Simultaneous differential equations, Simultaneous differential equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, Applications of ordinary differential equations.</p>
UNIT-III	<p>Algebraic Equations:(05Hrs) Elements of the theory of polynomial equations, Fundamental theorem of Algebra, Relation between the roots and coefficients of an equation, Transformation of equations, Solution of Cubic and Bi-quadratic equations.</p>

Books Recommended:

Text Books	<ol style="list-style-type: none">1. G. Prasad, Differential Calculus, Pothishala Private Limited.2. S. Narayan, Integral Calculus. S. Chand and Co.3. H. T. H Piaggio, Differential Equations and its applications, Orient Longman Limited.
Reference Books	<ol style="list-style-type: none">1. E. Kreyszig, Advanced Engineering Mathematics, New Age International Limited.2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa-2001.3. M. D. Raisinghania, Ordinary and partial equations, S. Chand & Co.



DEPARTMENT OF MATHEMATICS
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Mathematics-II (Code-MAL101)	Syllabus for B.Tech.-2nd Semester Common for all branches		Total Course Credit: 4		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective: To acquire the knowledge of Partial differential equations, Fourier series, Integral calculus, Matrices and apply them to various engineering Problems.

Course Outcomes (Cos):

CO1: Able to learn various methods for solving Partial differential equations of second and higher orders.

CO2: Able to apply partial differential equations for solving Heat equation and Wave equation.

CO3: Able to expand the given periodic function defined in the given range in terms of sine and cosine multiple of terms as a Fourier series.

CO4: Able to evaluate multiple integrals and improper integrals and Problems related to finding areas and volumes.

CO5: Able to find eigen values, eigen vector, Rank of matrix, index, signature of the quadratic forms, Solution of linear equations using rank.

UNIT-I	<p>Partial Differential Equations: (22Hrs) Partial differential equations of first order, Lagrange's linear equations, Standard forms, Partial differential equations of second and higher order, Homogeneous partial differential linear equations with constant coefficients, Non-homogeneous linear differential equations, Applications of partial differential equations, vibration of a stretched flexible string, Heat flow equation, Wave equation, Solution by the methods of separation of variables. Series solution of ordinary differential equations – Frobenius Method, Fourier series, Series solution.</p>
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UNIT-II	<p style="text-align: right;">(06Hrs)</p> <p>Integral Calculus: Differentiation under the sign of integration, Double and triple integrals, Change of order of integration, Change of variables, Beta and Gamma functions.</p>
UNIT-III	<p style="text-align: right;">(12Hrs)</p> <p>Matrices: Partitioning of Matrices, Hermitian and Skew- Hermitian Matrices, Orthogonal and Unitary matrices, Triangular matrices, Rank of a matrix, Equivalent matrices, elementary transformations, Inverse of a matrix, Solution of simultaneous equations by elementary operations, normal form, Eigen values and Eigen vectors of a matrix, Cayley- Hamilton theorem, Quadratic forms</p>

Books Recommended:

Text Books	<ol style="list-style-type: none"> 1. H. T. H Piaggio, Differential Equations and its applications, Orient Longman Limited. 2. S. Narayan, Integral Calculus. 3. S.C .Malik and S. Arora, Mathematical Analysis, New Age International Limited. 4. Kenneth Hoffmann and Ray Kunze, Linear Algebra, Prentice Hall of India, 2003.
Reference Books	<ol style="list-style-type: none"> 1. E. Kreyszig, Advanced Engineering Mathematics 2. Applied Mathematics for Engineers by P. N. Wartikar 3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa-2001. 4. M. D. Raisinghania, Ordinary and partial equations, S. Chand & Co. 5. Greenberg, Advanced Engineering Mathematics, 2/e Pearson Education, 2004.



DEPARTMENT OF PHYSICS
NATIONAL INSTITUTE OF TECHNOLOGY
HAZRATBAL, SRINAGAR, KASHMIR – 190 006 (J&K).

Subject: Engineering Physics. Code: PHL100	Common Syllabus for B.Tech. 1 st and 2 nd Semester of All Engineering Branches.		Total Course Credits: 04.			
Mid-Term	Class Assessment	Final-Term	Contact Hours			
			L	T	P	Total
[30 Marks]	[10 Marks]	[60 Marks]	3	1	0	4

Course Outcomes (COS)

CO1: Students will remember the concepts of vector calculus and will be able to apply in electrodynamics.

CO2: Students will understand basic quantum mechanics and will be able to evaluate related problems.

CO3: Students will understand the concepts of Theory of Relativity.

CO4: Students will understand and apply the working principle of lasers and optical fibers in various applications in science & technology. .

CO5: Students will understand and apply the concepts of semiconductor physics in solid state electronics devices.

Unit-I: VECTOR CALCULUS AND ELECTRODYNAMICS: (8 Hours)

Gradient, Divergence, curl and their physical significance. Laplacian in rectangular, cylindrical and spherical coordinates, vector integration, line, surface and volume integrals of vector fields, Gauss-divergence theorem, Stoke's theorem and Green Theorem of vectors. Maxwell equations, electromagnetic wave in free space and its solution in one dimension, energy and momentum of electromagnetic wave, Poynting vector, Problems.

UNIT-II: QUANTUM MECHANICS (8 Hours)

Origin of the quantum Mechanics, Interpretation of Wave function, Normalization, Schrodinger time-independent & time-dependent equations, basic postulates of the quantum Mechanics, Probability Current Density, Expectation values, Operators, Hermitian operators, Commutation relation between

Position & Momentum operators; Applications of Schrödinger equation in Particle in a box, Single step barrier, Harmonic Oscillator, Problems.

UNIT-III: SPECIAL THEORY OF RELATIVITY

(8 Hours)

Inertial Frames Of Reference, Galilian And Lorentz Transformations, Postulates of Relativity, Time Dilation, Twin Paradox, Length Contraction, Relativistic Mass, Energy and Momentum, Equivalence of Mass And Energy, Doppler Effect In Light And Its Application in Expanding of Universe, Problems.

UNIT-IV: LASER & FIBER OPTICS

(8Hours)

Introduction; Absorption and Emission, Einstein's coefficients & equations; Metastable states, Population inversion, Pumping (three and four level laser schemes), Basic parts of a Laser, Characteristics of Laser Radiations; Classification of Lasers, Ruby Laser, He-Ne Laser, GaAs Laser; Applications of lasers in holography. Basics of optical fiber, Total Internal Reflection, Acceptance angle, Numerical Aperture; Modes of Propagation, Single Mode Step Index Optical Fiber, Multimode Step Index Optical Fiber, Graded Index Fiber, Losses, Dispersion in Optical Fiber, Intermodal and intramodal dispersion, Applications of optical fiber; Problems.

Unit-V: SEMICONDUCTOR PHYSICS

(8 Hours)

Introduction to semiconductors; Intrinsic and extrinsic semiconductors; Direct and in-direct band gap semiconductors; Carrier concentration in semiconductors; mechanism of current conduction in semiconductors; Dependence of Fermi level on carrier-concentration, carrier generation and recombination; carrier transport: diffusion and drift; fabrication, mechanism and I-V characteristics of p-n junction; Zener diode; measurement of conductivity-four probe, , Hall effect; Problems.

BOOKS RECOMMENDED:

1. Introduction to Electrodynamics by David J. Griffith (Prentice- Hall of India Private limited).
2. Introduction to Classical Mechanics by R. G. Takwale and P.S. Puranik (Tata-McGraw Hill Publishing Co).
3. Concept of Modern Physics by Arthur Besier, Shobhit Mahajan & S. Rai Choudhury (McGraw Hill Education).
4. Quantum Mechanics by G. Aruldas (PHI learning).
5. Quantum Physics by H C Verma (Surya Publications, Ghaziabad).
6. Introduction to Special Relativity by Robert Resnick (Wiley).
7. LASERS (Theory and Application) by K. Thyagarajan & A.K. Ghatak (Macmillan).
8. Semiconductor Physics and Devices by Neamen Donald (McGraw Hill).
9. Physics of Semiconductor Devices by Kwok K. Ng & S. M. Sze (Wiley).



DEPARTMENT OF PHYSICS
NATIONAL INSTITUTE OF TECHNOLOGY
HAZRATBAL, SRINAGAR, KASHMIR – 190 006 (J&K).

Subject: Physics laboratory. Code: PHP-100	Common Syllabus for B.Tech. 1 st and 2 nd Semester of All Engineering Branches.	Total Course credits: 01.		
Mid-Term	Final-Term	L	T	P
[40 Marks]	[60 Marks]	0	0	2

Course Outcomes (COS)

CO1- Students will be able to understand the basic principle of designed experiments through simple scientific tools.

CO2- Students will be able to evaluate and interpret scientific data.

CO3- Students will be able to create different experiments based on scientific understanding.

List of Experiments

(Perform any Ten Experiments)

1. Determine the value of 'g' by bar pendulum.
2. Determine the value of 'g' by Kater's pendulum.
3. Determine the reduction factor of a tangent galvanometer.
4. To study the variation of magnetic field along the axis of current carrying circular coil.
5. Determination of the value of Stefan' constant.
6. Determination of young's modulus of elasticity by bending of beam.
7. Determination of refractive index of liquid using laser source.
8. Determination of absorption coefficient of liquid.
9. Determination of standing waves on a string by Melde' experiment.
10. Determine of wavelength of a monochromatic light by Newton's rings method.
11. Determine the wavelength of monochromatic light with Fresnel's biprism.
12. Determination of refractive index of prism by spectrometer.
13. Determination of specific charge using Magnetron valve/ helical method..
14. Determination of specific rotation of optically active substance by Polarimeter.
15. Study the Hall Effect and determine Hall coefficient, carrier density and carrier mobility of a given semiconductor.
16. Determine the band gap of a given semiconductor material.
17. Determination of a Planck's constant by measuring radiation in a fixed spectral range.
18. Determine the coefficient of viscosity of glycerin by falling sphere method.

19. Study of the characteristics of a G.M. Counter and to study of the statistical nature of radioactive decay.
20. To study the characteristics of a solar cell.

BOOKS RECOMMENDED:

1. Practical Physics by Gupta & Kumar (Pragati Prakashan Meerut).
1. Sharma Saroj, "Physics Experiments for Engineers" (Oscar publications, New Delhi).
2. Singh, Devraj, "Engineering Physics" (Dhanpat Rai & Co., New Delhi).
3. Thiruvadigal, J. D., Ponnusamy, S., Sudha. D and Krishnamohan M., "Physics for Technologists" (Vibrant Publication, Chennai).
4. Shukla R. K., and Srivastava Anchal, "Practical *Physics*", (New Age International (P) Ltd, New Delhi).
5. Arora C.L., "B.Sc. Practical Physics" (S. Chand & Company Limited).
6. Souires G. L., "Practical *Physics*" (Cambridge University, UK).
7. Chattopadhyay D., Rakshit P. C., and Saha B., "An Advanced Course in Practical Physics", (Books & Allied Ltd., Calcutta).



DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Engineering Chemistry (Code-CYL100)	Syllabus for B.Tech.-1stYear Common for all branches			Total Course Credit:4		
Mid-Term	Class Assessment	Final-Term	L	T	P	
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0	

Course Objective: To impart the knowledge of engineering chemistry and their applications in different engineering disciplines.

Course Outcomes (COs)

- CO1:** To learn the basic concepts of water chemistry and softening methods.
- CO2:** To understand the properties and uses of polymeric materials.
- CO3:** To gain knowledge about fuels, types of lubricants and their uses.
- CO4:** To learn fundamentals of corrosion and its prevention techniques.

UNIT-I	<p>High Polymers (10 Hrs)</p> <p>Introduction, classification, types of polymerization, mechanisms of polymerization (free radical, cationic, anionic), coordination polymerization and its mechanism, synthesis and applications of some important engineering polymers (Polyethylene, PVC, Polystyrene, Teflon, Polyesters, polyamides, Bakelite and silicones), conducting polymers; classifications, properties and applications in engineering field.</p>
UNIT-II	<p>Water Chemistry (10 Hrs)</p> <p>Introduction, sources of water, impurities in water, hard water, units of hardness, determination of hardness and alkalinity, softening of hard water; Lime-Soda process, Zeolite process and Ion Exchange process, numerical problems based on hardness, alkalinity and LS process, municipal treatment of water for drinking purposes; removal of suspended, dissolved and biological impurities-sterilization by chlorination (Effective and break-point chlorination).</p>
UNIT-III	<p>Fuels and Lubricants (10 Hrs)</p> <p>Fuels: Introduction, classification of fuels, characteristics of a good fuel calorific value; HCV and LCV, Dulong's formula, Determination of calorific value by Bomb Colorimeter, Numerical problems. Coal: analysis of coal - proximate and ultimate analysis, significance of the analysis.</p> <p>Lubricants: Introduction, mechanisms of lubrication, hydrodynamic, boundary and extreme pressure lubrication, classification of lubricants: liquid, semi solid</p>

	and solid lubricants. Lubricating oils; fatty oils, mineral oils, blended oils, properties of lubricating oils with special reference to flash point, aniline point, viscosity and viscosity index.
UNIT-IV	<p>Corrosion and its Prevention (10 Hrs)</p> <p>Introduction, types of corrosion: Dry and wet corrosion (pitting corrosion, crevice corrosion, stress corrosion, inter-granular corrosion), corrosion prevention and control by proper design and material selection, cathodic protection, anodic protection, protective coatings.</p>

Books Recommended:

Text Books	<ol style="list-style-type: none"> 1. P. C. Jain: Engineering Chemistry, 16th. Edition, Dhanpat Rai Publishing Company, India. 2. Dara S.S., A Text Book of Engineering Chemistry, 12th. Edition, S. Chand and Company, India. 3. J. C. Kuriacose and J Rajaraman; Chemistry in engineering and Technology, Volumes I and II, Tata Mc Graw Hill Publishing Co. Limited, New Delhi
Reference Books	<ol style="list-style-type: none"> 1. V. R. Gowriker, N.V. Viswanathan and jayadev Sreedhar: Polymer Science, Wiley Eastern Limited, New Delhi. 2. C.V. Agarwal: Chemistry of Engineering Materials (Tata Publishing Works, Varsnasi). 3. R. M. E. Diamand: Applied Chemistry for engineers (Pitman).



DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

ENGINEERING CHEMISTRY LAB COURSE

Subject: Engineering Chemistry Lab Code-CYP-100	Syllabus for B.Tech-1 st Year Common for all branches		Course Credit: 01		
	Mid-Term	Final-Term	Total	L	T
30 (Marks)	70 (Marks)	100 (Marks)	0	0	2

Sr. No.	Experiments
1.	To determine the total, permanent and temporary hardness of water by EDTA method.
2.	To determine alkalinity of given water samples/alkali mixtures by warder's Method.
3.	To estimate percentage of available chlorine (free chlorine) in bleaching powder/water.
4.	Synthesis of Phenol formaldehyde resin.
5.	Synthesis of Urea formaldehyde resin.
6.	Proximate analysis of coal.
7.	To determine the acid value of given lubricating oils.
8.	To determine the aniline point of given lubricating oils.



**DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR
HAZRATBAL, SRINAGAR - 190006 (J&K)**

Subject: Engineering Drawing (Code: CIP100)	Syllabus for B.Tech.-1st Year Common for all branches	Total Course Credit: 4			
Mid-Term	Class Assessment	End-Term	L	T	P
30 Marks	10 Marks	60 Marks	2	0	4

Course Objective: To inculcate the ability to translate geometric and topological information of common engineering object (two/three dimensional) into engineering drawing using standard graphical techniques..

Course Outcomes:

CO1: Comprehend general projection theory, with an emphasis on the use of orthographic projection to represent three-dimensional objects in two-dimensional views.

CO2: Apply auxiliary or sectional views to most practically represent engineered parts.

CO3: Understand the intersection, development of surface of body and fasteners.

CO4: To interpret Orthographic, Isometric and Perspective views of objects.

S. No.	Contents	Contact Hours
01.	Introduction to engineering drawing, dimensioning, points, lines, planes. Types of projections, concept of solid as 3-dimensional object, lines and planes, first and third angle practices. Projections of lines, planes and simple geometrical solids, placed in simple positions with single rotation of the face, edge or axis of solid with respect to one of the principal planes of projection.	24
02.	Section of simple geometrical solids, types of sectional planes, true shape of sections	12
03.	Intersection of surfaces, simple case of intersection of two prisms, two cylinders, and cone and a cylinder Development of surfaces of simple sectional solids and intersecting solids	12
04.	Isometric projections of given orthographic projections. Orthographic projections of simple blocks	12

Text book:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

References:

1. Gopalakrishna K. R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Shah M. B., and Rana B. C., "Engineering Drawing", Pearson, 2nd Edition, 2009.
3. Luzzader, Warren. J. and Duff, J. M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Venugopal K. and Prabhu R. V., "Engineering Graphics", New Age International (P) Limited, 2008.
5. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
6. Basant A. and Agarwal C. M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
7. Gowri S., and Jeyapoovan T., "Engineering Graphics" Vikas Publishing House (P) Limited, 2011.



**DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR
HAZRATBAL, SRINAGAR - 190006 (J&K)**

Subject: “Engineering Mechanics” (Code: CIL100)	Syllabus for B.Tech.-1st Year Common for all branches	Total Course Credit: 4			
Mid-Term	Class Assessment	End-Term	L	T	P
30 Marks	10 Marks	60 Marks	3	1	0

Course Objective:

To establish an understanding of the techniques needed to solve general engineering mechanics problems.

Course Outcomes:

CO1: Determine the resultants in plane force systems. Identify and quantify all forces associated with a static framework.

CO2: Calculate the center of gravity, center of mass, and centroid for simple and composite volumes. Determine moment of area of plane sections

CO3: To determine the forces in members of a plane truss.

CO4: Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tri-dimensional elastic solids

CO5: To introduce shear force and bending moment diagrams, different beams with different loading conditions and relationship between loads, shear force and bending moment.

S. No.	Contents	Contact Hours
Section 1: Mechanics of Rigid body		
01.	Statics: Fundamental concepts and laws of mechanics. Equilibrium of bodies: Free-body diagrams, conditions of equilibrium, torque due to a force, statical determinacy. Force systems: principle of moments, resultant of forces, couple systems, equilibrium of rigid bodies, Support reactions.	12
02.	Properties of plane surfaces: First moment of area, centroid, second moment of area etc.	5
03.	Plane trusses: Forces in members of a truss by method of joints and method of sections.	5
04.	Friction: General concept of friction. Static and Dynamic Friction.	2
Section 2: Mechanics of Deformable Bodies		
05.	Concept of stress and strain: Conditions of equilibrium, compatibility and stress strain relations. Stress-strain diagrams, Hooke’s law, Modulus of elasticity (E), Lateral strains, Poisson’s ratio, Multi-axial stress system, Volumetric strain, Bulk	08

	modulus (K), Shear stress concept, Modulus of rigidity (G). Relation between E, G and K.	
06.	Concept Shear force and bending moment: Support conditions, determination of shear forces & bending moments in beams, shear & moment diagrams, Analysis of beams for different loading conditions, Relation between load, shear force & bending moment.	08

Textbook:

1. Hibbeler, R.C., "Mechanics of Materials", 6th SI edition, Prentice Hall.
2. Hibbeler, R.C., Engineering Mechanics: Statics and Dynamics, Prentice Hall (2012).

References:

1. Beer, P.F. and Johnston (Jr.) E.R. "Mechanics of Materials", S.I. Version, Tata McGraw Hill, India, 2001.
1. Beer, Johnston, Clausen and Staab, Vector Mechanics for Engineers, Dynamics, McGraw-Hill Higher Education (2003)
2. Timoshenko and Young, Engineering Mechanics, Tata McGraw Hill Education Private Limited (2000).
3. Shames, I. H. Engineering Mechanics: Dynamics, Pearson Education India (2002).
4. Popov, E.P., Engineering Mechanics of Solids, Prentice-Hall, 1999.
5. Gere J.M. and Goodno, B. J., Strength of Materials, Cengage Learning.
6. Craig, R.R., "Mechanics of Materials", 2nd edition, John Wiley and Sons.



DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Environmental Studies CYL101	Syllabus for B.Tech.-1stYear Common for all branches		Total Course Credit: 3		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	2	1	0

Course Objective: To impart the knowledge and awareness for the environmental protection for real-time contribution during an execution of engineering practices in the society.

Course Outcomes (COs)

- CO1:** To understand the basic concepts of environmental studies and natural resources.
- CO2:** To learn about the eco-systems, biodiversity and its conservation.
- CO3:** To gain knowledge about different types of environmental pollutions and their control measures.
- CO4:** To learn the fundamentals of social issues, population and the environment.

Course Contents:

Unit 1: The Multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness.

Unit 2: Natural Resources

Renewable and non renewable resources:

Natural resources and associated problems

Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.

Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity,

case studies. Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies. Land Resources: Land as a resource, land degradation, man induces landslides, soil erosion, and desertification. Role of individual in conservation of natural resources. Equitable use of resources for sustainable life styles.

Unit 3: Eco Systems

Concept of an eco-system, Structure and function of an eco-system. Producers, consumers, decomposers. Energy flow in the eco systems. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following eco systems:

- i. Forest ecosystem
- ii. Grass land ecosystem
- iii. Desert ecosystem.
- iv. Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

T 4: Biodiversity and it's Conservation

Introduction-Definition: genetics, species and ecosystem diversity. Biogeographically classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local level. India as a mega diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts. Endangered and endemic spaces of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT 5: Environmental Pollution

Definition Causes, effects and control measures of:

Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies, Disaster management: Floods, earth quake, cyclone and land slides

Unit 6: Social issues and the Environment

Form unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, water shed management, Resettlement and rehabilitation of

people; its problems and concerns, case studies, Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies.

Wasteland reclamation, Consumerism and waste products, Environment protection Act

Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection act, Forest conservation act, Issues involved in enforcement of environmental legislations, Public awareness.

Unit 7: Human population and the environment

Population growth and variation among nations, Population explosion- family welfare program, Environment and human health, Human rights, Value education, HIV/AIDS, Women and child welfare, Role of information technology in environment and human health, Case studies

Unit 8: Field work

Visit to a local area to document environment assets river/forest/grassland/ hill/mountain. Visit to a local polluted site-urban/rural/industrial/agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hills lopes, etc (field work equal to 5 lecture works)

Recommended Books:

1. Textbook of Environmental studies, Erach Bharucha, UGC
2. Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd

Course Title: Elements of Mechanical Engineering

Course Code: MEL 100

L-T-P: 3-0-0,

Total Credits: 3

Offered to: First Year Engineering Students

Course Objective:

This course is intended to enlighten the first year undergraduate students about some of the technical issues that mechanical engineering addresses, and identify its impact in solving global, social, environmental, and economic problems.

Course Outcomes: With this course the student should specifically be able to:

1. Identify and select materials and manufacturing processes for fabricating prototypes and engineering products.
2. Explain the significance of thermodynamic processes in energy conversion and conservation.
3. Explain the significance of fluids engineering to energy conversion, and to diverse fields as aerodynamics, medicine, etc.
4. Identify and select various motion and power transmission elements for a particular application.

Materials and Manufacturing Techniques: Recent advances in mechanical engineering, Role of Computer Aided Design, Simulation and 3D printing. Units and measurements. Engineering Materials and Materials Response. Basic manufacturing processes, conventional and non-conventional fabrication processes.

Thermal and Energy Systems: System and Surroundings, Thermodynamic processes, First and Second law of thermodynamics, Concept of Entropy. Engine Cycles and Efficiency. Basic idea of internal combustion engines. Heat transfer through conduction, convection and radiation. Heat exchangers. Energy conservation and conversion.

Fluid Properties and their Applications: General properties of fluids, Fluid statics, Pressure measurement. Equation of fluid motion, Bernoulli's Equation. Viscous Effects: Viscosity, Laminar and Turbulent Flows. Introduction to hydraulic machines: turbines, pumps, their types and applications in energy conversion.

Motion and Power Transmission: Rotational motion, Design application: Gears, Speed, torque and power in gear sets. Simple and compound gear trains, Design application: Belt and Chain drives.

Recommended Texts:

1. An introduction to Mechanical Engineering by Jonathan Wickert, and Kemper Lewis, Fourth Edition, Cengage Learning, 2017.

Other resources:

1. Basics of Mechanical Engineering; Integrating Science Technology and Common Sense by Paul D Ronney, USC.
<http://ronney.usc.edu/ame101/>

**Central Workshop National
Institute of Technology
Hazratbal, Srinagar-190006, Kashmir**

**Syllabus
Of
Workshop Practice
B. Tech First Year**

Central Workshop

General Workshop Practice

The field of engineering continues to grow rapidly, transcending disciplines & driving economic growth. Workshop practices have become significant in the industrial environment to manufacture products for the service of the mankind. Workshop Practice is a core subject & is highly essential for all engineers & technocrats for formalizing themselves with the latest techniques & concepts of manufacturing & is the basic requirement for all the engineering students. In addition to introduction of various tools, processes & materials, the student has to acquire practical knowledge & skills of using machines & equipment, Various Cutting, measuring & marking tools, performing main operations through simple exercises.

Manual abilities to handle engineering materials with hand tools need to be developed in the students. They will be using different types of tools/ equipments in different engineering trades for fabrication purposes. Before developing the necessary skills, the students will appreciate the importance of quality & safety measures.

Detailed Contents

1. The students are supposed to be in proper workshop dress prescribed by the institute.
2. Wearing shoes in the workshop is compulsory.
3. Importance of safety measures, cleanliness & up keep of tools, equipment in each of the following engineering trades should be explained & practised.
4. The student should prepare the sketches of various tool/ jobs in their practical note book. The practical academic activities of various semesters are carried out in the following seven engineering trades.
 - a) Machining Section (Machinist trade & turning trade)
 - b) Sheet metal & Spray painting section
 - c) Fitting & Bench work section
 - d) Welding section
 - e) Foundry & Casting section
 - f) Smithy & Forging section
 - g) Carpentry & Pattern making section

**NATIONAL INSTITUTE OF TECHNOLOGY
SRINAGAR**

Central Workshop

Course title: Workshop Practices (WSP100)

Year: First Year (All Branches)

Credit: 2

Course No: - WSP100

L-T-P: - 0-0-5

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

CO1	Perform the operations of plain turning, taper turning, facing, knurling, grooving, drilling on a given cylindrical Mild steel work piece using various cutting, measuring & machine tools.
CO2	Distinguish between various tools & joints. Design & develop different components like cylinder, funnel of a galvanized iron sheet work piece using various operations such as marking cutting, measuring, soldering etc.
CO3	Recognize suitable tools to design a single & split piece pattern moulds & casting of these moulds using Aluminum & Lead. Define various testing processes of molding sand. Identify & selection of various tools to perform different operations of forging.
CO4	Develop various joints such as butt joint, lap joint, corner joint using different welding processes such as electrical arc welding, MIG welding & TIG Welding. Understand different welding electrodes & other welding processes such as resistance welding, submerged arc welding.
CO5	Identify & apply suitable hand tools & holding equipments to perform basic operations to make a square plate, snap joint, cross joint of a Mild Steel Work Piece.
CO6	Recognize suitable wood working hand tools & equipments to make various joints like half lap cross joint, mortise-tenon joint & bridle joint of soft wood (Deodar). Understand various pattern making techniques.

Machining Trade

(Machinist Trade & Turning Section)

(a) Theoretical Instructions:

Safety Precautions, Introduction of machine tools such as lathe, Drilling machine & other related metal cutting tools. Parts of lathe & basic metal cutting operations. Introduction of various types of cutting tools (Nomenclature) and their material.

(a) Practical Demonstrations:

Demonstration on Lathe & basic operations such as drilling, facing, turning, taper turning, step turning, knurling, chamfering etc. Demonstration of basic measuring instruments.

**Job No. 1: TO MANUFACTURE THE JOBS ON THE CENTRE
LATHE AS PER GIVEN DRAWING.**

**Job No. 2: TO PERFORM ADDITIONAL OPERATIONS SUCH AS
GROOVING, DRILLING, KNURLING on Job No. 1.**

Sheet Metal & Spray Painting section

(a) Theoretical Instructions:

Safety precautions, brief introduction of sheet metal, various tools, joints & operations. Soldering, brazing, & shearing, Fluxes & their applications. Introduction of different machines and pattern development in detail. Brief description of paints & varnishes

(b) Practical Demonstrations:

Demonstration of all basic hand tools & equipments. Fabrication of simple joints and jobs. Preparation & painting of surfaces for varnish & painting etc.

Job No. 1: TO DEVELOP A CYLINDRICAL JOB.

**Job No. 2: TO DEVELOP A SQUARE ELBOW WITH
SOLDERING AS PER THE DRAWING.**

Fitting & Bench Work section

(a) Theoretical Instructions:

Safety precautions, introduction to fitting & bench work. Demonstration of basic hand tools, holding devices and basic fitting operations such as measuring, marking, filing, sawing, drilling, tapping, buffing.

(b) Practical Demonstrations:

Demonstration of all basic hand tools/ measuring tools & equipments. Demonstration of simple operations such as marking, punching, filing, sawing, scrapping, drilling.

Job No. 1: TO FABRICATE A SQUARE PLATE OF MILD STEEL WORK PIECE 50X50X7 mm.

Job No. 2: TO ASSEMBLE THE MILD STEEL WORK PIECE WITH SNAP FITTING.

Welding Section

(a) Theoretical Instructions:

Safety Precautions, Introduction of welding processes like electric arc welding, Gas Welding, MIG Welding, TIG welding, Submerged arc welding & spot welding.. Various Fluxes & electrodes used in welding. Introduction of ac & dc welding and its applications.

(b) Practical Demonstrations:

Demonstration of all basic tools & personal protective equipments. Demonstration of different types of joints by using arc welding & gas welding etc.

Job No. 1 : TO MAKE A SINGLE-V BUTT JOINT OF MILD STEEL 80x50x8mm Job

No. 2 : TO MAKE A LAP JOINT OF MILD STEEL 85x35x6mm

Smithy & Forging section

(a) Theoretical Instructions:

Safety precautions, introduction of forging tools .Materials & their heat treatments. Description of all forging operations such as hand forging, upsetting, drawing & punching. Introduction of various forging methods. Comparison of hot & cold working.

(b) Practical Demonstrations:

Demonstration & practice of different smithy operations like forging, cutting, punching, bending etc. Demonstration & practice of MS rod into forged MS ring & octagonal cross section.

Job No. 1: TO PREPARE MS-SQUARE 20X20MM FROM MS ROUND BY USING DIFFERENT FORGING HAND TOOLS.

Job No. 2: TO PREPARE A SQUARE HEADED BOLT FROM MS-ROUND 60x30mm

Carpentry & Pattern Making section

(a) Theoretical Instructions:

Safety Precautions, Introduction of carpentry & joinery, different tools used in carpentry. Seasoning of wood and defects of wood. Various types of joints. Brief description of wood working machines and pattern making.

(b) Practical Demonstrations:

Demonstration & practice of different carpentry operation like Planning, sawing & chiseling and joints. Demonstration of pattern making tools & materials.

Job No. 1: TO PREPARE HALF LAP CROSSJOINT.

Job No. 2: TO PREPARE A BRIDLE JOINT

Foundry & Casting Section

(a) Theoretical Instructions:

Safety precautions, Brief Introduction to foundry. Different casting processes. hand tools, gating system. Molding sands & its properties. Types of pattern, allowances, gates. Selection of pattern. Core Sand & Core making. Defects & remedies. Cupola furnace. Molding sand tests. Melting temperature of different metals.

(b) Practical Demonstrations:

Demonstration & practice of mould making & metal pouring. use of split patterns & cores, sand preparation & testing . Use of hand tools to prepare the mould.

Job No. 1: TO PREPARE A GREEN SAND MOULD BY USING SINGLE PIECE PATTERN.

Job No. 2: TO PREPARE A CASTING OF SINGLE PIECE PATTERN.

List of recommended books:-

- 1) Workshop Technology by Chapman.
- 2) Workshop Technology by Hajra Chowdhary
- 3) Workshop Technology by Swarn Singh
- 4) Workshop Technology by Virender narula

MECHANICAL ENGINEERING DEPARTMENT

Subject: Manufacturing Processes (Code: MET201)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Identify and analyse the functioning of machine tools and estimate the machining time
- CO2:** Explain and analyse the conventional machining processes
- CO3:** Analyse the welding process behaviour for fusion and solid state welding techniques
- CO4:** Explain the basics of casting processes and their applications in manufacturing domain

Detailed Syllabus:

UNIT I

Introduction to manufacturing processes, Introduction to machine tool. Basic elements of machine tool, machine tool drives. Lathe machine: Tool geometry, machining parameters. Lathe operations (Facing, Turning, Drilling, Reaming, Boring), Taper turning by different methods. Milling Machine: types, working principle, milling parameters, operations (slab, end, slot, face milling), up and down milling. Estimating machining time in lathe and milling operations, different types of indexing methods in milling

UNIT II

Drilling: Types of drilling machines, portable, bench, upright, Radial, Spot facing. Drilling process parameters, Estimating machine time. Reaming: Types of reamer, reaming operations. Broaching: Types of broaches, tool material, teeth terminology and other details. Methods of broaching. Working principle and operation of shaping, planing and slotting

UNIT III

Welding: Introduction to welding, Principle of Welding, Classification of welding, Arc Initiation, Characteristic and power of electric arc, Power source characteristics, Modes of metal transfer in Arc welding, Gas welding, SMAW, GTAW, GMAW, Resistance and Thermit welding, High energy beam welding, Solid state welding processes, Underwater Welding, Welding defects, Welding of Plastics

UNIT IV

Casting Processes: Introduction, Industrial applications, casting terminology, mould, types of mould (Grey and Dry sand Mould), Pattern types, allowances, preparation of mould, various stages in the

casting process, testing of moulding sand, types of casting processes (Die, Centrifugal, Continuous, and investment casting), Solidification time, Gating and rising system design

Text Book:

1. Ghosh, A. and Malik, A.K., “Manufacturing Science”, Affiliated East Press, New-Delhi.

Reference Books:

1. Campbell, J.S., “Principles of Manufacturing Materials and Processes”, McGraw-Hill, New-York.
2. Rao, P.N., “Manufacturing Technology”, Vol. 2, McGraw-Hill Education, New Delhi.
3. Lindberg, R.A., “Processes and Materials of Manufacturing”, Allyn and Bacon, Boston.
4. Schey, J.A., “Introduction to Manufacturing Processes”, McGraw-Hill, New-York.
5. Sindo Kou, “Welding Metallurgy”, 2nd Edition, Wiley-Interscience.

Subject: Mechanics of Solids (Code: MET202)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Evaluate and solve statically determinate and indeterminate problems
- CO2:** Determine the resistance and deformation in machine members subjected to axial, flexural and torsional loads
- CO3:** Evaluate principal stresses, strains and apply the concept of failure theories for design
- CO4:** Analyze thin and thick cylinders and design closed-coil helical and leaf springs

Detailed Syllabus:

UNIT I

Concept of Resistance and deformation, determinate and indeterminate problems in tension and compression, thermal stresses, pure shear, Young's modulus of elasticity, Poisson's ratio, Modulus of rigidity and Bulk modulus, relation between elastic constants, Stress-strain diagrams for brittle and ductile materials, working stress, Strain energy in tension and compression, Impact loading

UNIT II

Analysis of Stress and Strain, Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal planes, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions, Thin and Thick Cylinders, spherical shells subjected to internal fluid pressure, Wire-wound thin cylinders, Compound cylinders, Shrink fit.

UNIT III

Shear Force and Bending Moment, types of supports and beams, types of loads, articulated beams, Shear Force and Bending Moment diagrams, Theory of Simple Bending, Bending stresses in beams, Efficiency of various cross-sections, Composite beams, Flexural shear stress distribution in different cross sections of beams, Deflection of Beams, Slope and deflection of beams, Double Integration method, Macaulay's method, strain energy method

UNIT IV

Torsion of Circular cross sections, theory of pure torsion, transmission of power in solid and hollow circular shafts, Combined bending and torsion, Springs, Axial load and torque on helical springs, stresses and deformations, strain energy, compound springs, leaf springs, Strain Energy, Castigliano's theorems I and II, Load-deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.

Text Books:

1. Hibbeler, R. C., "*Mechanics of Materials*" 8th Edition, Pearson Education India, 2011.
2. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers, 2011.
3. Shames, I. H., Pitarresi, J. M., "Introduction to Solid Mechanics", Pearson, 2015.

Reference Books:

1. Popov, E. P., "Engineering Mechanics of Solids", PHI, 2009.
2. Beer, F. Jr., Johnston, E. R., DeWolf, J., Mazurek, D., "Mechanics of Materials", 7th Edition, McGraw-Hill Education, 2014.

Subject: Fundamentals of Dynamics (Code: MET203)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Apply the concepts and laws of dynamics to solve complex engineering problems
- CO2:** Use the concepts of impulse-momentum to develop relations governing particle impacts
- CO3:** Use Newton's second law to determine trajectory properties of particles under central-force attraction
- CO4:** Apply the knowledge of dynamics of rigid bodies to systems like ships and airplanes

Detailed Syllabus:

UNIT I

Kinematics of particles, basic concepts, rectilinear motion, plane curvilinear motion, rectangular coordinates (x-y), normal and tangential coordinates (n-t), polar coordinates (r- θ), space curvilinear motion, relative motion (translating axes), constrained motion of connected particles

UNIT II

Kinetics of particles, equations of motion and their solution, impulse, momentum, work and energy, linear impulse and linear momentum, angular impulse and angular momentum, impact, central-force motion, relative motion, kinetics of systems of particles, generalized Newton's second law, work-energy, impulse-momentum, conservation of energy and momentum

UNIT III

Dynamics of rigid bodies, rotation, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, motion relative to rotating axes, plane kinetics of rigid bodies, translation, fixed-axis rotation, general plane motion, mass moments of inertia

UNIT IV

Work energy relations, virtual work, impulse-momentum equation, and three-dimensional dynamics of rigid bodies, gyroscopic motion, and steady precession

Text Book:

1. Meriam, J. L., Kraige, L. G., Bolton, J. N., "Engineering Mechanics: Volume 2, Dynamics", 9th Edition, Wiley, 2018.

Reference Book:

1. Shames I. H. and Rao, G. K., "Engineering Mechanics Statics and Dynamics", Pearson Education India; 4th Edition, 2005.

Subject: Engineering Thermodynamics (Code: MET204)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Apply the basic concepts of thermodynamics to engineering systems
- CO2:** Apply various laws of thermodynamics to solve problems involving heat and work transfer
- CO3:** Design heat engines and heat pumps using the knowledge of basic thermodynamic cycles
- CO4:** Develop fundamental relations between various thermodynamic properties to evaluate the un-measurable properties

Detailed Syllabus:

UNIT I

Introduction and basic concepts, microscopic and macroscopic views of matter, thermodynamic systems, properties, processes, cycles, thermal equilibrium, the state postulate, Zeroth law of thermodynamics, temperature, temperature scales, thermodynamic equilibrium, energy and the First law of thermodynamics, mechanical forms of work, internal energy, conservation of energy, energy transfer as work and heat, First law for a closed system, specific heats, isothermal, isobaric, and isentropic processes, compressibility.

UNIT II

First law for open systems, enthalpy, First law for cyclic processes, applications, Second law of Thermodynamics, Entropy and the Second law, Various statements of the Second law and their equivalence, Clausius statement, Kelvin-Planck statement, reversible cycles, Carnot cycle, inequality of Clausius, the principle of increase of entropy and its applications, Second law for closed systems, Second law for open systems.

UNIT III

The Maxwell relations, Gibb's function, Helmholtz function, relationship between specific heats, the Clapeyron equation, thermodynamic relations for ideal gases, computation of entropy and internal energy from measurable quantities, process with ideal gases and vapours, Ideal gas mixtures, Dalton's law of partial pressures, Gibbs-Dalton law, Amagat's law of additive volumes

UNIT IV

Internal energy, enthalpy, specific heat and entropy of an ideal gas mixture, air-water vapour mixture, complete and incomplete combustion analysis, heating value of fuels, analysis of products of combustion, Orsat apparatus.

Text Books:

1. Moran, M.J., Shapiro, H.J., Boettner, D.D., Bailey, M.B., “Fundamentals of Engineering Thermodynamics”, John Wiley, 2018.
2. Cengel, Y., Boles, M., and Kanoglu, M., “Thermodynamics: An Engineering Approach”, McGraw Hill, 2019.

Reference Books:

1. Wark, K., “Thermodynamics”, McGraw Hill, 2001.
2. Van-Wylen, G.J., “Fundamentals of Classical Thermodynamics”, John Wiley, 2001.

Subject: Fluid Mechanics-I (Code: MET205)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Apply the basic laws of hydrostatics to engineering problems involving static fluids and submerged surfaces
- CO2:** Evaluate and apply the principles of continuity, momentum, and energy conservation to systems involving fluid motion
- CO3:** Apply the Bernoulli equation to compute pressure and velocity changes in flow systems of different configuration and appreciate the application of elementary potential theory
- CO4:** Apply the knowledge of fluid dynamics to determine head losses in circular pipes and use elementary boundary-layer theory to determine lift and drag forces in engineering systems

Detailed Syllabus:

UNIT I

Definition of a fluid, methods of analysis, system and control volume, differential versus integral approach, methods of description, fluid as a continuum, velocity field, timelines, path lines, streak lines, and streamlines, stress field, viscosity, Newtonian and non-Newtonian fluids, surface tension, viscous and inviscid flows, laminar and turbulent flows, the basic equation of fluid statics, pressure variations in a static fluid, manometers, hydraulic systems, hydrostatic force on submerged surfaces, buoyancy and stability, fluids in rigid-body motion

UNIT II

Conservation of mass, control volume formulation, differential control volume, control volume moving with constant velocity, momentum equation for control volume with rectilinear acceleration, the angular-momentum principle, equation for fixed control volume, equation for rotating control volume, the rate of work done by a control volume, differential analysis of fluid motion, stream function and velocity potential, fluid translation, acceleration of a fluid particle in a velocity field, fluid rotation, fluid deformation, momentum equation, Navier-Stokes equations

UNIT III

Incompressible inviscid flow, momentum equation for frictionless flow, Euler's equation, Bernoulli equation, integration of Euler's equation along a streamline, static, stagnation, and dynamic pressures, applications of the Bernoulli equation, the Bernoulli equation interpreted as an energy equation, energy grade line and hydraulic grade line, unsteady Bernoulli equation, irrotational flow, stream function and velocity potential, Laplace's equation, superposition of elementary plane flows

UNIT IV

Dimensional analysis and similitude, non-dimension alization of the basic differential equations, Buckingham Pi theorem, determining the π groups, significant dimensionless groups, flow similarity and model studies, internal incompressible viscous flow, fully developed laminar flow between infinite parallel plates, fully developed laminar flow in a pipe, flow in pipes and ducts, shear stress distribution, turbulent velocity profiles in fully developed pipe flow, energy considerations in pipe flow, kinetic energy coefficient, head loss calculation, major and minor losses, friction factor, restriction flow meters for internal flows, boundary-layer theory, boundary-layer thicknesses, laminar flat-plate boundary layer, momentum integral equation for flow with zero pressure gradient, friction and pressure drag, streamlining, aerodynamic lift

Text Book:

1. Pritchard, P. J., Leylegian, J. C., "Fox and McDonald's Introduction to Fluid Mechanics", Eighth edition, John Wiley and Sons, Inc., 2011.

Reference Books:

1. Shames, I. H., "Mechanics of Fluids", Fourth Edition, McGraw Hill, 2003
2. White , F.M., "Fluid Mechanics", McGraw Hill, 2001

Subject: Machine Drawing & Solid Modelling (Code: MEL201)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 2		
			L	T	P
			0	0	4
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Draw machine elements including keys, couplings, cotters, rivets, bolted and welded joints, using the conventions for engineering components and materials
- CO2:** Construct an assembly drawing using part drawings of machine components
- CO3:** Create part drawing of machine components using machine assembly
- CO4:** Apply geometric modelling techniques in design and analysis

Detailed Syllabus:

UNIT I

Introduction to machine element drawing, review of dimensioning, types of sectioning and use, need and significance of version control in drawings, methods of recording modifications in typical drawings, Introduction to generation of drawings as a design process for machine assembly. Use of datum planes to locate features and machine elements uniquely in assemblies. Standardized representation and types of threads, fasteners, welds.

UNIT II

Introduction to important machine elements such as bearings (rolling contact/sliding contact), Use of appropriate fits for correct functioning, representation of springs and related components, detailing of components involving shafts, bearing, pulleys, gears, belts, brackets for assembly, generation of assembly drawings using standard modeling software including sectioning and bill of materials, evolving details of components from assembly considerations.

UNIT III

Solids Modelling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modelling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modelling methods in CAD software. Data Exchange Formats and CAD Applications.

UNIT IV

Development of three-dimensional models and fabrication/assembly drawings from engineering sketches and orthographic drawings and utilization of three-dimensional models in design work. Introduction to engineering topics such as finite-element analysis (FEA) and computational fluid dynamics (CFD). Additional advanced topics include stress/deflection calculations using beam theory mathematical models.

Text Books:

1. Bhatt, N.D., “Machine Drawing”, Charotar Publishing House, 2003.
2. Saxena A. and Sahay B., “Computer-Aided Engineering Design”, Anamaya Publishers, New Delhi, 2005.

Reference Books:

1. Sidheswar, N., Kannaiah, P. and Sastry, V.V.S., “Machine Drawing”, Tata McGraw Hill Book Company, New Delhi, 2000.
2. Mortenson M. E., “Geometric Modeling”, Tata McGraw Hill, 2013.

Subject: Applied Mathematics for Engineers (Code: MAT205)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Solve problems related to differentiation and integration of complex functions
- CO2:** Express complex functions in terms of series expansion, classify singularities and the apply the concepts of complex analysis in boundary value problems and potential theory
- CO3:** Evaluate Laplace, Inverse Laplace transforms, Fourier and Inverse Fourier transforms of various functions and related problems
- CO4:** Apply the methods of Laplace and Fourier transforms in solving ODE, PDE and Integral equations

Detailed Syllabus:

UNIT I

Complex Variables: Function of a Complex variable, Limit, Continuity and Differentiability of complex function. Cauchy-Riemann Equations, Analytic function, Harmonic functions, Complex Integration Cauchy Integral Theorem and its consequences, Taylor Series, Laurant Series, Classification of Singularities, Residues, Cauchy's Residue Theorem and its Applications, Zeros of Analytic functions.

UNIT II

Boundary Value Problems and Potential Theory, Laplace's Equation and Conformal Mappings, Standard Solution of Laplace equation, Steady-State Temperature Distribution, Steady Two Dimensional Fluid Flow.

UNIT III

Laplace transform, Laplace transform of some elementary functions, Properties of Laplace transform, Differentiation and Integration of Laplace transform, Dirac-delta function and its Laplace transform, Heaviside's expansion theorem, Inverse Laplace transform, Initial and Final value theorems, Convolution theorem, Use of Laplace transforms in the solution of linear differential equation.

UNIT IV

Fourier Transforms, Definition of Fourier transform, Fourier Integral Theorem, Properties of Fourier transform, Fourier sine and cosine, Convolution Theorem, Applications of Fourier transforms to Ordinary and Partial differential equations.

Text Books:

1. Brown, W., and Churchill, R. V., "Complex Variables and Applications," 8th Edition, McGraw Hill International Edition, 2009
2. Debnath, L., and Bhatta, D., "Integral Transforms and their Applications," 2nd Edition, CRC press, 2007

Reference Books:

1. Jeffrey, A., "Complex Analysis and Applications," 2nd Edition, CRC Press, 2005
2. Needham, T., "Visual Complex Analysis," Oxford University Press
3. Jain, R. K., and Iyengar, S. R. K., "Advanced Engineering Mathematics," 3rd Edition, Narosa Pub. House, 2008
4. Spiegel, M. R., "Schaum's Outlines Laplace Transforms," Tata Mc-Graw Hill, 2005

Subject: Mechanics of Solids Lab (Code: MEL202)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester	Total Course Credit: 1		
		L	T	P
		0	0	2
Evaluation Policy	Continuous Assessment (40 Marks)	End-Term (60 Marks)		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Determine the tensile or compressive strength of different material and interpret various critical point locations on the stress-strain diagram
- CO2:** Identify different engineering materials, describe their properties and predict their behaviour under different types of loading
- CO3:** Determine elastic constants using various flexural and torsion tests
- CO4:** Determine the mechanical properties of materials by destructive methods

List of Experiments:

1. To study the stress-strain characteristics of (a) Mild Steel and (b) Cast Iron by conducting tension test on UTM
2. To study the stress-strain characteristics of (a) Copper and (b) Aluminum by conducting tension test on Hounsfield Tensometer
3. To find the compressive strength of wood and punching shear strength of G.I. sheet by conducting relevant tests on Hounsfield Tensometer
4. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminum (d) Copper by conducting hardness test
5. To determine the modulus of rigidity by conducting Torsion test on (a) Solid shaft (b) Hollow shaft
6. To find the modulus of rigidity of the material of a spring by conducting compression test
7. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam
8. To determine the modulus of elasticity of the material by conducting deflection test on a propped cantilever beam
9. To determine the modulus of elasticity of the material by conducting deflection test on a continuous beam
10. To investigate the load deflection characteristics of various types of spring and determine their spring rate

Subject: Manufacturing Processes Lab (Code: MEL203)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester	Total Course Credit: 1		
		L	T	P
		0	0	2
Evaluation Policy	Continuous Assessment (40 Marks)	End-Term (60 Marks)		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Describe the geometry of single point cutting tool
- CO2:** Apply knowledge of metal cutting to perform various machining operations
- CO3:** Explain the working and use of various components of conventional machine tools
- CO4:** Investigate the effect of machining process parameters on surface roughness

List of Experiments:

1. To study the construction details and working principle of Lathe Machine.
2. To perform taper turning operation on Lathe Machine
3. To perform step turning operation on Lathe Machine
4. To study the tool geometry of a single point cutting tool.
5. To perform drilling operation on a given work piece using Drilling Machine
6. To perform shaping operation on a given work piece using Shaper Machine
7. To perform external thread cutting operation on Lathe Machine
8. To investigate the effect of turning process parameters on the surface roughness of machined component

Subject: Applied Thermodynamics (Code: MET251)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Identify and describe the various components of boilers and power plant
- CO2:** Explain the operation of steam turbines and steam power plants
- CO3:** Explain the operation of diesel and gas turbine power plants and address the general challenges in thermal power plants
- CO4:** Analyze the principles and applications of refrigeration systems and air-conditioning processes using the principles of psychometry.

Detailed Syllabus:

UNIT I

Pure Substance, Ideal and real Gases, perfect gases, Generation of Steam, use of Steam Tables and Mollier diagram, various phases of a substance, triple point and critical point, sub-cooled liquid, saturated liquid, vapor pressure, two-phase mixture of liquid and vapor, saturated vapor and superheated vapor states of a pure substance (with water as an example), dryness fraction and its measurement, representation of the properties of a pure substance on p-T, h-s and p-V diagrams, detailed treatment of properties of steam for industrial and scientific use.

Vapor Power cycles: Carnot vapor power cycle, Effect of pressure & temperature on Rankine cycle, Reheat cycle, Regenerative cycle, Feed water heaters, Binary vapor cycle, combined cycles, Cogeneration, Air standard Cycles, Carnot, Otto, Diesel and dual cycles, work output and efficiency, mean effective pressure, deviation of actual cycles from ideal cycles

UNIT II

Fuels and Combustion: Combustion analysis, Heating Values, Air requirement, Air/Fuel ratio, Standard heat of reaction and effect of temperature on standard heat of reaction, heat of formation, adiabatic flame temperature.

Boilers: Steam generators-classifications, working of fire-tube and water-tube boilers, boiler mountings and accessories, draught and its calculations, air preheater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance, Condensers: classification, Air leakage, Condenser performance parameters

UNIT III

Nozzles: Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, off design operation of nozzle, Effect of friction on nozzle, super saturated flow. Steam Engines: Rankine and modified Rankine cycles, working of steam engine, Steam Turbines :Classification of steam turbine, Impulse and reaction turbines, Staging, Stage and overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple & compound multistage impulse & reaction turbines & related calculations work done efficiencies of reaction, Impulse reaction Turbines, state point locus, Comparison with steam engines, Losses in steam turbines, Governing of turbines.

UNIT IV

Applications of Refrigeration and Air-conditioning, Thermal Principles for Refrigeration, Vapor Compression System, Reversed Carnot Cycle, Survey of Refrigerants, Designation of Refrigerants, Selection of Refrigerants, Thermodynamic Requirements, Centrifugal compressors, Multistage compression, multi-evaporator system, cascade systems, Condensers, Heat Transfer in Condensers, Evaporators, Heat Transfer in Evaporators, Extended surface Evaporator, Cooling and Dehumidifying coils, Automatic or constant-pressure expansion valve, Psychometric properties, Wet bulb temperature, Psychometric chart, mixing process.

Text Books:

1. Eastop, T. D., "Applied Thermodynamics for Engineering Technologist", Pearson Education, 1990.
2. Arora, C. P., "Refrigeration and Air-conditioning", McGraw Hill, New Delhi,

Reference Books:

1. Helsdon, R. M., Hiller, N., Walker, G. E., "Introduction to Applied Thermodynamics", Elsevier, 1965.
2. Pai, B. U., "Turbomachines", 1st Edition, Wiley.
3. Hundy, G. H., Trott, Albert Runcorn, Welch, T., "Refrigeration, Air Conditioning and Heat Pumps," 5th Edition, Butterworth-Heinemann, Elsevier.

Subject: Mechanics of Materials (Code: MET252)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Apply the fundamental concepts of stress and strain and their relationships to solve problems for three-dimensional elastic solids
- CO2:** Explain the concept of buckling of columns and solve the problems related to isolated bars
- CO3:** Solve problems relating to torsional deformation of bars and other simple three-dimensional structures
- CO4:** Apply principles of linear elasticity in the design and analysis of structures such as curved bars, crane hooks, thin plates

Detailed Syllabus:

UNIT I

Stress in three dimension: Concept of continuum, homogeneity and isotropy, types of force on a body, state of stress at a point, equality of cross shear, Cauchy formula, principal stresses and planes, stress invariants, hydrostatic and deviatoric stress tensor, Mohr's circle for general state of stress, stress transformations, octahedral stresses, differential equation of equilibrium. Strain in three dimension: Types of strain, strain displacement relationship, shear strain, rigid body rotation, principal strain and axes, strain deviator and invariants, compatibility conditions, concept of plane stress and strain, stress strain relationship.

UNIT II

Theories of Elastic Failure: Concept of factor of safety, Maximum Principal Stress Theory, Maximum Principal Strain Theory, Maximum Shear Stress Theory, Strain Energy Theory, Distortion energy theory. Buckling of columns: Concept of buckling and stability, differential equations of compression member with different boundary conditions, eccentrically loaded columns, secant formula, column with initial imperfections, Rankine formula.

UNIT III

Stresses due to rotation: Rotating ring, rotating thin disc, and rotating thin solid and hollow disc, disc of uniform strength, rotating long solids and hollow cylinders. Torsion of non-circular member: St. Venant's theory, approximate solution of rectangular and elliptical sections, rigorous solution, stress function approach, membrane analogy, torsion of thin hollow section, torsion of thin and open sections.

UNIT IV

Bending of curved bars: Introduction, stresses in curved bars (Winkler-Bach theory) having rectangular, circular, triangular and trapezoidal section, stresses in crane hooks. Bending of thin plates: Assumption of plate theory, governing differential equations for deflection of plates, boundary conditions, solution for rectangular plate.

Text Books:

1. Hibbeler, R. C., "*Mechanics of Materials*", 6th Edition, East Rutherford, NJ: Pearson Prentice Hall, 2004
2. Srinath L. S., "*Advanced Mechanics of Solids*", TMH Publishing Company Limited, 1992

Reference Books:

1. Boresi A. P., Schmidt R. J., Sidebottom O. M., "*Advanced Mechanics of Materials*", 5th Edition, John Wiley & Sons, 1993
2. Cook, R. D., Young, W. C., "*Advanced Mechanics of Materials*", Collier Macmillan Publishers, 1985
3. Ugural A. C., S. K. Fenster, "*Advanced Mechanics of Materials and Applied Elasticity*", Prentice Hall; 5th Edition, 2011

Subject: Theory of Mechanisms and Machines (Code: MET253)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Select and analyse the kinematic parameters for designing a suitable linkage mechanism
- CO2:** Explain the working principle of governors and gyroscopes in motion control
- CO3:** Select and design gear and cam mechanisms for a given input and output motion relationship
- CO4:** Apply the laws of friction in applications of mechanisms and machines

Detailed Syllabus:

UNIT I

Mechanism and machine, links and kinematic pairs, degrees of freedom, kinematic chain, mechanical advantage, transmission angle, inversions of four bar and slider crank mechanisms, Quick-return mechanism, straight line generators, velocity and acceleration analysis using instantaneous centre method and loop-closure equations, computer-aided analysis of four bar mechanism, graphical and computer-aided synthesis for motion and path generation

UNIT II

Governors, Watt governor, Porter governor, Proell governor, Hartnell governor, controlling force, sensitivity, stability, hunting, isochronism, effort and power of a governor, gyroscope, gyroscopic torque, gyroscopic effects on an airplane and ships, gyroscopic stabilization, stability analysis of a two-wheel vehicle, four-wheel drive on a curved path

UNIT III

Gears, classification, law of gearing, involute and cycloidal profiles, path and arc of contact, contact ratio, interference and undercutting, interchangeable gears, helical, bevel and spiral gears, gear trains, classification, simple, compound, reverted, and epicyclic gear trains, analysis of epicyclic gear trains, sun and planet gears, automobile differential

UNIT IV

Friction, types and laws of friction, screw jack, pivots and collars, bearings, friction clutches, brakes, Cams, classification and terminology, displacement diagrams, derivatives of follower motion, pressure angle and undercutting, motions of the follower, layout of cam profiles, graphical and analytical disc cam profile synthesis

Text Book:

1. Pennock, G. R., Shigley J. E., Uicker, J. J., "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, 2014.

Reference Books:

1. Bevan, T., "Theory of Machines", 3rd Edition, CBS publishers and distributors, 2005.
2. Norton, R. L., "Kinematics and Dynamics of Machinery", Tata McGrawHill, 2009.
3. Ghosh A. and Mallick A. K. "Theory of Mechanisms and Machines" East West Private Limited, New Delhi, 1988.
4. Rattan S. S. "Theory of Machines", 5th Edition, Tata McGrawHill, 2019.

Subject: Materials Science and Engineering (Code: MET254)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Explain the underlying concepts of engineering material chemistry and crystallography
- CO2:** Determine crystallographic directions and explain imperfections in solids, and processing of engineering materials
- CO3:** Explain the mechanisms of strengthening and the phase diagrams
- CO4:** Recognize the need of heat treatment processes and analyse the effect of cooling media on microstructure

Detailed Syllabus:

UNIT I

Introduction to material science and engineering, Importance of materials, Classification of engineering materials, Modern and advanced materials, Atomic structure and bonding, Fundamentals of electron arrangements and modern periodic table, Primary bonds and secondary bonds. Crystallography, Concept of unit cells and lattice arrangements, Crystal structure, Crystal systems, Bravais lattices, Co-ordination number, Atomic packing factor

UNIT II

Miller indices of direction and planes, single crystals, polycrystalline materials, Amorphous material, x-ray diffraction and determination of crystal structures, Imperfections in solids, point defects, line defects and volume defects, dislocations.

Ceramics: structure, types, properties and applications of ceramics, processing of ceramics. Composite materials. Nanomaterials and their potential applications. Plastics: Types of plastics/polymers, polymer structure, thermoplastic and thermosetting polymers, processing of polymers

UNIT III

Deformation and strengthening mechanisms, strain hardening, grain refinement, mechanical alloying, solid solution strengthening, precipitation hardening. Diffusion in solids, Phase diagrams, Solubility limit, Phases, Lever rule, Gibbs phase rule, Iron-Carbon equilibrium diagram. Mechanical properties and testing, Non-Destructive testing

UNIT IV

Heat Treatment: Introduction to heat treatment, different types of heat treatment processes, annealing, normalizing, quenching, tempering, case hardening, Time temperature transformation

diagram, Recovery, Recrystallization, Ductile to brittle transition. Micro-structure of various metals and alloys, Micro structure of steel treated with different cooling media.

Text Book:

1. Callister Jr, W. D., Rethwisch, D. G., “Materials Science and Engineering: An Introduction”, 8th Edition, John Wiley and Sons.

Reference Books:

1. Raghvan, V., “Materials Science and Engineering”, 5th Edition, Prentice Hall India Learning Private Limited, 2005.
2. Ghosh, A., and Malik, A. K., “Manufacturing Science”, 2nd Edition, Pearson India, 2010.

Subject: Non-Traditional Machining and Automation (Code: MET255)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Analyse and assess the importance of automation and industrial automated systems
- CO2:** Identify and analyse functions and functioning of CNC machines
- CO3:** Recognize the need of non-traditional machining processes and understand the working of high energy beam machining
- CO4:** Illustrate underlying mechanisms in non-traditional machining processes along with their applications

Detailed Syllabus:

UNIT I

Introduction to automation and manufacturing automation, types of automation, Introduction to Flexible manufacturing systems (FMS), Elements, types and advantages of FMS, Cellular manufacturing, Types of flexibilities in FMS, test of flexibility, Product processing strategies. Introduction to robotics, Elements of Robotic Systems

UNIT II

Computer numeric control (CNC) machines, Open loop & closed loop CNC machines. Classification, advantages and applications of CNC machines, Introduction to CNC programming, G-codes and M-codes. Absolute and Incremental coordinate system, Adaptive control, Material Handling Equipment, Automated Guided vehicles (AGVs), Analysis of AGVs

UNIT III

Introduction to machining processes. Limitations of traditional machining processes. Introduction, need and applications of non- traditional machining processes. Classification of non- traditional machining processes. Mechanical machining, thermal machining, electrochemical machining. Introduction, working and applications of high energy beam machining processes. Virtual machining

UNIT IV

Introduction, working, process parameters and applications of Abrasive Jet Machining (AJM), Abrasive water jet machining (AWJM), Ultrasonic machining (USM), Electric Discharge Machining (EDM), Electrochemical machining (ECM). Introduction to Wire Electric Discharge Machining (WEDM). Effect of input parameters on material removal in AJM, USM and EDM.

Text Books:

1. Groover, M. P., “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall Press, United States, 2007.
2. Ghosh, A., and Mallik, A.K., “Manufacturing Science”, 2nd Edition, East-West Press, New-Delhi.

Reference Books:

1. Kumar, K., Zindani, D., Davim, J. P., “Advanced Machining and Manufacturing Processes”, Springer, Switzerland.
2. Groover, M. P., “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, 5th Edition, Wiley Publication.

Subject: Basic Electronics (Code: ECT266)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 3		
			L	T	P
			3	0	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Explain the basic principles associated with semiconductor electronics
- CO2:** Explain the behavior of different types of diodes and transistors at the circuit level
- CO3:** Analyze and explain the behavior of operational amplifiers and their applications
- CO4:** Apply the knowledge of digital logic gates and blocks in designing digital electronic circuits

Detailed Syllabus:

UNIT I

Introduction to semiconductors: Intrinsic and extrinsic semiconductors transport mechanism of charge carriers, electric properties, temperature dependence, and p-n junction diode: current components in p-n junction, characteristics-piece wise linear approximation, and diode circuit's half wave, full wave rectifiers, photo diodes

UNIT II

BJT: Operation and characteristics: CE, CB and CC configuration input, output characteristics biasing and bias stability, low frequency, h-parameter model, analysis and design of transistor amplifier circuits using h-parameters. Multistage amplifiers, transistor as a switch. Introduction to feedback and sinusoidal oscillators, FET's operation and characteristics, JFET model, application at low and high frequency, amplifiers, switching circuits, MOSFET types, operation and characteristics

UNIT III

Operational Amplifier: Operational amplifiers stages, differential amplifier, CMRR, cascade amplifier, ideal and practical operational amplifier characteristics and properties OP-amp applications, inverting and non-inverting amplifiers, difference amplifier, summer differentiator and integrator, rectifiers etc. Instrumentation amplifier

UNIT IV

Digital Logic: Introduction to Boolean theorems and codes, code conversion; Logic gates, combinatorial and sequential blocks

Text Books:

1. Millman, J., Halkias, C., Jit, Satyabrata, "Milman's Electronics Devices and Circuits", Tata McGraw Hill Education, 2010
2. Mano, M Morris, "Digital logic and computer design", Pearson Education India, 2017

Reference Books:

1. Behzad Razavi, "Fundamentals of Microelectronics", Wiley, 2008
2. Mottershed, A., "Electronic Devices and Circuits: An Introduction", Prentice Hall India, 1979.
3. Uyemura, J., "Digital System Design An Integrated Approach", Nelson Engineering, 1999.

Subject: Thermo-Fluids Lab (Code: MEL251)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester	Total Course Credit: 1		
		L	T	P
		0	0	2
Evaluation Policy	Continuous Assessment	End-Term		
	40 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Calibrate flow and discharge measuring devices like the venturimeter and orifice meters
- CO2:** Determine fluid flow properties and characterize laminar and turbulent flows
- CO3:** Prepare heat balance sheet for steam boilers
- CO4:** Determine COP of a refrigerator and identify various parts of a cooling tower

List of Experiments:

Thermal:

1. Determination of calorific value using a Bomb Calorimeter.
2. Study of Various Types of Boilers, Boiler Mountings and Accessories
3. Performance and Energy Balance Test on a Fire Tube/ Water Tube Boiler.
4. Study of Refrigeration System and determination of its COP.
5. Study of a cooling tower.

Fluid Mechanics:

1. To determine the viscosity of a fluid by falling sphere (ball) viscometer.
2. To study the flow through a variable area duct and verify Bernoulli's energy equation.
3. To determine the coefficient of discharge for an obstruction flow meter (Venturimeter/orifice meter).
4. To study the transition from laminar to turbulent flow and to ascertain lower critical Reynolds number.
5. To determine the friction coefficient for pipes of different diameters.
6. To determine the velocity distribution for pipeline flow with a Pitot static probe and to measure pressure with pressure sensors.
7. To study the flow visualization through wind tunnel.

Subject: Non-Traditional Machining and Automation Lab (Code: MEL252)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester	Total Course Credit: 1		
		L	T	P
		0	0	2
Evaluation Policy	Continuous Assessment	End-Term		
	40 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

- CO1:** Explain the working and use of various components of CNC machines.
- CO2:** Identify the sequence of codes to process a job
- CO3:** Create CNC programs for turning and milling operations
- CO4:** Perform machining operation on Wire Electric Discharge Machine

List of Experiments:

1. To Study the fundamentals of CNC Machine
2. To Study the different codes used in CNC Machine
3. To perform drilling operation on CNC Milling Machine
4. To perform slotting operation on CNC Milling machine
5. To perform turning operation on CNC Lathe Machine
6. To produce given profile using CNC Milling Machine
7. To perform machining operation on Wire Electric Discharge Machine (WEDM)
8. To investigate the effect of WEDM process parameters on the surface roughness of the machined component.

Reference Book:

1. Overby, A., “CNC Machining Handbook: Building, Programming and Implementation”, McGraw-Hill, 2010.

Semester-V

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET301	Heat Transfer	3	1	0	4	4
2.	MET302	Design of Machine Elements	3	1	0	4	4
3.	MET303	Mechanical Vibrations	3	1	0	4	4
4.	MET304	Industrial Engineering - I	3	1	0	4	4
5.	MET305	IC Engines	3	1	0	4	4
6.		Microprocessors in Automation	3	0	0	3	3
7.	MEL310	Heat Transfer Lab	0	0	2	2	1
8.	MEL311	Mechanisms and Vibrations Lab	0	0	2	2	1
Total Credits						25	

Subject: Heat Transfer (Code: MET301)	Year & Semester: B. Tech Mechanical Engineering 3rd Year & 5th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

After the completion of course, students will be able,

CO1	Identify, formulate and solve steady, transient and multidimensional heat conduction problems.
CO2	Understand the phenomenon of convection and be able to evaluate heat transfer coefficients for natural and forced convection.
CO3	Calculate radiation heat exchange between black as well as non-black surfaces
CO4	Be able to solve a wide range of real world problems involving conduction, convection and radiation

Unit I

Introduction, Physical origins and rate equations, conduction, convection, radiation, relationship to thermodynamics, Combined conduction-convection-radiation problems, Importance of heat transfer, conduction rate equation, thermal conductivity, general heat conduction equation, boundary and initial conditions, one dimensional steady heat conduction, plane wall, thermal resistance, composite wall, contact resistance, alternate conduction analysis, one dimensional steady heat conduction in cylinders and spheres, critical radius of insulation, one dimensional steady state heat conduction with heat generation in plane walls, cylinders and spheres, heat transfer from extended surfaces, fins with constant area, fin performance.

Unit 2

Two-dimensional steady state heat conduction, method of separation of variables, conduction shape factor and dimensionless conduction heat rate, unsteady heat conduction, Lumped capacity analysis, criteria for lumped capacity analysis, transient heat conduction in a semi-infinite solid, Biot and Fourier numbers, transient heat conduction in large plane walls, long cylinders and spheres with spatial effects, transient heat conduction in multi-dimensional systems.

Unit 3

Convection boundary layers, Velocity and thermal boundary layer, local and average heat transfer convection coefficients, derivation of differential convection equations, solutions of convection equations for a flat plate, Nusselt and Prandtl numbers, relation between fluid friction and heat transfer, Turbulent-boundary-layer heat transfer, flow across cylinders and spheres, flow across tube banks, Internal forced convection, mean velocity, mean temperature, empirical relations

for pipe and tube flows, Free convection heat transfer on a vertical flat plate, Grashof and Raleigh numbers, Empirical relations for free convection, Combined free and forced convection.

Unit 4

Thermal radiation, black and gray surfaces, Radiation laws, Radiation shape factor, relation between shape factors, Radiation heat exchange between black bodies, Radiation heat exchange between non-black bodies, Radiation shields, Condensation heat transfer phenomenon, condensation number, film condensation inside horizontal tube, boiling heat transfer, simplified relations for boiling heat transfer with water, heat exchangers, overall heat transfer coefficient, fouling, types of heat exchangers, log mean temperature difference, Effectiveness-NTU method, Compact heat exchangers.

Textbooks:

1. Incropera, F.P., Dewitt, D.P., Bergman, T.L., Lavine, A.S., “Principles of Heat and Mass Transfer”, Wiley, 2017.
2. Holman, J.P., “Heat Transfer, McGraw Hill, 2011.

Reference Books:

1. Bejan, A., “Heat Transfer”, John Wiley, 1993.
2. Cengel, Y.A., Ghajar, A.J., “Heat Transfer”, McGraw Hill, 2020.

DESIGN OF MACHINE ELEMENTS

Course No.: MET 302

CLT (431)

Core Course Pre-requisites: Engineering mechanics, Mechanics of solids and Engineering materials science.

Course objective: To teach Mechanical Engineering Students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.

Course Content:

UNIT I

Design requirements, Selection of materials and manufacturing considerations in design.

Riveted joints: Introduction, Types of riveted joints, Failures of riveted joints, Strength of riveted joint, Efficiency of riveted joint. Design of longitudinal butt joint and circumferential lap joint for a Boiler.

Bolts, Nuts & Screws: Introduction, Advantages & disadvantages, Definitions, Forms of screw threads, Common types of screw fastenings, locking devices. Designation of screw threads, Stresses in screwed fastening due to static loading.

Welded connections: Introduction, Advantages & disadvantages of welded joints, welding processes, fusion welding, thermit welding, gas welding, Electric arc welding, forge welding. Types of welding joints, Lap joint, Butt joint, Strength of transverse fillet welded joints, strength of parallel fillet welded joints, special cases of fillet welded joints, axially loaded unsymmetrical welded sections.

UNIT II

Stress concentration: Theoretical or form stress concentration factor, Stress concentration factor due to holes and notches, Methods of reducing stress concentration. Cyclic loading and endurance limit: Completely Reversed or cyclic stresses, Fatigue and endurance limit, effect of loading on endurance limit, Effect of surface finish, size and miscellaneous factors on endurance limit. Combined steady and variable stress: Gerber method for combination of stresses, Goodman method for combination of stresses, Soderberg method for combination of stresses.

UNIT III

Cotter and Couplings: Types of cotter joints, Socket and spigot cotter joint, Design of socket and spigot cotter joint, Design of sleeve and cotter joint. Types of shaft couplings, Design of sleeve and muff coupling, Design of flange coupling.

Power Screws: Types of screw threads used for power screws, Torque required to raise load on square threaded screws, torque required to lower load by square threaded screws, Efficiency of square threaded screws, Maximum efficiency of a square threaded screw. Over Hauling and Self locking screws. Design of screw jack.

Shafts: types of shafts, design of shafts, shafts subjected to twisting Moment only, Shafts subjected to bending moment only, shafts subjected to combined twisting moment and bending moment.

Course Outcomes:

On successful completion of the course, Students should be able to:

1. Demonstrate knowledge on basic machine elements used in machine design.
2. Understand the stress and strain on machine components and identify and quantify failure modes for machine parts.

3. Design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
4. Approach a design problem successfully, taking decisions when there is not a unique answer.

Course Assessment:

Students will be assessed on:

1. Continuous assessment in the form of homework, assignments, attendance, and presentations (10% weightage).
2. One and half hour written exams designated as Mid-term (30% weightage).
3. Two hour written exams designated as End-term (60% weightage).

Text Books:

1. Ullman D.G., "The Mechanical Design process", 3rd edition, McGraw Hill, 2009.
2. Mott, R.L., "Machine Elements in Mechanical Design", 4th edition, Prentice Hall, Singapore, 2005.
3. Shigley, J.E., Mischke, C. Brown T., "Standard Hand book of Machine Design", McGraw Hill.

Reference Books:

Shigley, J.E., "Hand Book of Machine Design", McGraw Hill, 2004

Subject: Mechanical Vibrations (Code: MET303)	Year & Semester: B. Tech Mechanical Engineering 3rd Year & 5th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, a student should be able to:

CO1: Develop the mathematical models of vibrating systems, determine their DOF, and determine the free and forced vibration response of such systems.
CO2: Determine the response of linear time-invariant systems to arbitrary forcing conditions using the convolution integral and the Laplace Transform method.
CO3: Formulate the equations of motion of multiple degree of freedom systems, express it as an eigen value problem and determine the free and force vibration response.
CO4: Derive the equations of motion of a continuous system, determine its natural frequencies and mode shapes, and obtain the free vibration response to given initial conditions.

Detailed Syllabus:

UNIT I

Harmonic Motion, Vibration Terminology, Complex Methods of Representing Harmonic Motion, Fourier Series and Harmonic Analysis, Free and Forced Vibrations, Degrees of Freedom, Mathematical Modeling of Vibrating Systems, Differential Equations of Motion, Solution of the Differential Equation of Motion, Torsional Vibrations, Various Types of Damping, Dry Friction or Coulomb Damping, Structural Damping, Viscous Damping. Logarithmic Decrement, Energy Dissipated By Damping, Equivalent Viscous Damping, Introduction to Energy Methods.

UNIT II

Forced Harmonic Vibrations, Rotating Unbalance, Support Motion, Vibration Isolation and Control, Vibration Measuring Instruments, Vibration Pickups, Vibrometers and Accelerometers, Vibrations under General Forcing Conditions, Impulse Excitation, Arbitrary Excitation, Convolution Integral, Use of Laplace Transforms, Pulse Excitation and Rise Time, Shock Response Spectrum, Shock Isolation.

UNIT III

Two-Degree-of-Freedom Systems, Normal Mode Analysis, Coordinate Coupling and Principal Coordinates, Forced Harmonic Vibration, Vibration Absorbers and Vibration Dampers, Generalized Coordinates, Natural Frequencies and Mode Shapes, Modal Analysis, Multi-degree-of-Freedom Systems

UNIT IV

Continuous Systems, Longitudinal Vibration of a Bar, Equation of Motion and Solution, Orthogonality of Normal Functions, Lateral Vibration of Beams, Equation of Motion, Initial Conditions, Boundary Conditions, Effect of Axial Force, Effects of Rotary Inertia and Shear Deformation, Whirling of Shafts, Critical Speeds, Balancing of Rotating Shafts, Single-Plane Balancing, Two-Plane Balancing

Text Book:

1. Grover, G. K., Mechanical Vibrations, 7th edition, Nem Chand and Bros, New Delhi, India 1996.

Reference Books:

1. Thomson, W. T., Theory of Vibrations with applications, Fifth Edition, Pearson Education, 2004.
2. Rao, S. S., Mechanical Vibrations, Sixth Edition, Pearson Education.

COURSE OUTCOMES:

- 1. Understanding the concept and applications of industrial engineering with a focus on productivity, work design and work study.**
- 2. Analysing & applying the method study techniques in relation to a particular job environment.**
- 3. Analysing & evaluating various engineering work measurement techniques designed to establish the time for a qualified worker to carry out a specific job at a defined level of performance.**
- 4. Attain a grasp of the fundamental principles of experimental design, collection of data related to work study, their analysis and interpretation.**

UNIT I

Concept of industrial productivity: Introduction and significance of Industrial engineering with brief explanation of its techniques, Functions of Industrial Engineering, Definitions and explanation of Productivity with significance in Industries, Productivity measurements, Factors affecting productivity, Basic work content and excess work content, Industrial applications to calculate total and partial productivities, Introduction to Work study and its basic procedures, definitions and concept of work study with examples, Human factor in the application of work study, Factors for selecting the work study, Ergonomics: scope and objectives of ergonomics, application of human factors in engineering work place design, etc.

UNIT II

Introduction to Method study and the selection of jobs, Record, Examine and Develop, Objectives and basic procedure of Method study, Recording techniques (Process Charts (PC), and Diagrams), Outline PC, Flow process charts, Two hand process charts, MAC (??), Simo chart, Flow diagram, String diagram, Cycle graph, Chronocycle graph, Travel chart, Define, Install and Maintain, the principles of motion economy,

UNIT III

Work measurement and its applications, Time study, Work Sampling, Rating and their methods,

Breaking the jobs into Elements, types of Elements, Allowances and their calculations, Calculation of Standard time, Examples of Time study, PMT (??) systems, synthetic data, Various applications and examples.

Text Book:

1. Barnes, R.L., "Motion and Time Study, Design & Measurement of Work" 7th edition, John Wiley & Sons, New York, 1980.

Reference Books:

1. International Labor Office, Geneva, "Introduction to Work Study" 4th Edition, Geneva, 1985.
2. Currie R.M, "Work study", ELBS & Pitman, London, 1977.
3. Mundel, M.E., "Motion and Time Study", 5th Edition, Prentice Hall, Englewood Cliff, NewYork, 1978.

MET305	INTERNAL COMBUSTION ENGINES	3-1-0	Credits: 4
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Prerequisites: Thermodynamics, Heat Transfer

Course Outcomes: At the end of the course, the student should be able to:

CO1:	To understand the internal combustion engine design as the largest prime mover for all applications in the world.
CO2:	To understand combustion related characteristics of engine and its fuels.
CO3:	To understand the essential systems of IC engines.
CO4:	To understand numerical on engine design, engine emissions, emissions measurement and its control.

Unit 1

Introduction : Engine classification.

Design and operating parameters: Geometry and geometrical properties, working principle of Two stroke and Four stroke engines, Analysis of air-standard cycles, fuel-air cycles and actual engine cycles, Thermodynamics of actual working fluids, Air capacity of four stroke engines: Ideal air capacity , Volumetric efficiency , ideal induction process , actual induction process, Effect of operating conditions on volumetric efficiency, Effect of design on volumetric efficiency , estimating air capacity. Valve and port timing diagram.

Supercharging and Scavenging in IC engine : Methods of supercharging and turbo-charging in SI and CI engine, limits of supercharging in SI and CI engine. Scavenging in two stroke cycle engines, scavenging parameters and efficiency

Unit 2

Combustion in SI and CI Engine: Classification of fuel, solid, liquid and gaseous fuels, fuel properties and fuel rating, Alternative fuels, mixture requirements, characteristics of SI and CI engine fuels. Combustion and detonation: chemistry of combustion, normal combustion in S.I engines , pre- ignition and auto-ignition comparison, detonation in S.I engines, combustion in C.I engines, detonation in C.I engines, Methods of reducing detonation , preliminary detonation, preliminary facts about fuel and dopes, octane and cetane numbers, effect of design on detonation. Mixture requirements: Steady running, mixture requirements, transient mixture requirements, mixtures requirements for fuel injection engines, mixture requirements for S.I engines. Use of combustion charts for burned mixture Appropriate treatment of fuel air mixtures.

Unit 3

Fuel Injection system: Types of carburetor, mixture requirements, single point and multipoint injection system in SI engine, rate of fuel injection in CI engine, fuel injection pumps and nozzle. Current injection systems in I C engines.

Ignition System: Battery ignition, Magneto ignition and Electronic ignition, factors affecting spark advance, spark advance mechanism. Current ignition systems.

Engine friction and lubrication: Components of engine friction, friction mean effective pressure, Blow by losses, effect of engine variables on friction, side thrust on piston. lubrication principle, types of lubrication ,properties of lubricant.

Heat transfer and Cooling system: Engine temperature distribution, heat transfer consideration, gas temperature variation, effects of operating variables on heat transfer , air cooling and liquid cooling systems, concept of adiabatic engine, Numerical on heat transfer in IC engines.

Unit 4

Engine Testing and performance: Measurement of indicated power, brake power, fuel consumption, air flow rate, engine speed, spark timing, performance characteristics, Numerical on engine design, determination of main dimensions, Numerical on two stroke engines and four stroke engines. Numerical on heat transfer in IC engines, Engine design and principles of similitude. Numerical on alternative fuels, Numerical on diesel fuel injection system, Numerical on verification of engine commercial specifications.

Exhaust Emissions: Pollutants from IC engines. mechanism of pollution formation, methods of emission control, Effect of alternative fuels, Emission norms.

Measurement Of Exhaust Emissions. NDIR, FID, CLA, measurement of exhaust smoke, gas chromatography, effect of operating variables on SI and CI engine pollutant.

Text Book:

1. Heywood, John B. Internal Combustion Engine Fundamentals. McGraw-Hill Book Company.

Reference Books:

1. V. Ganeshan: I. C. Engines: Tata McGraw Hill, New Delhi, 4/e
2. W. W. Pulkrabek: Engineering Fundamentals of I. C. Engines, Prentice Hall India
3. M K Gajendra Babu and K A Subramanian; Alternative Transportation Fuels; CRC Press.

Course No.: **XXXX** **MICROPROCESSORS IN AUTOMATION** C L T (3 3 0)

COURSE OUTCOMES: (To be given by ECE dept., not obtained by the mechanical Dept. till date)

(To be obtained from ECE Department)

Subject: HEAT TRANSFER LAB (Code: MEL310)	Year & Semester: B. Tech Mechanical Engineering 3rd Year & 5th Semester		Total Course Credit: 1		
			L	T	P
			0	0	2
Evaluation Policy					

After the completion of course, students will be able,

CO1	Acquire a thorough outlook regarding the steps to design and conduct experiments for measuring specific physical variables
CO2	To apply the concepts learnt in Heat Transfer theory subject to do hands on experiments
CO3	To calculate the thermal conductivity, heat transfer coefficient, and other parameters relevant in heat transfer
CO4	Communicate effectively in completing written reports of laboratory work

List of Experiments

1. To determine the thermal conductivity of a metal bar
2. To determine the thermal conductivity of a liquid
3. To study the heat transfer through the insulating medium
4. To study heat conduction in a composite wall
5. To study heat transfer from a pin fin
6. To study heat transfer in natural convection
7. To study heat transfer in forced convection
8. To study the heat transfer phenomena in a heat exchanger with parallel / counter flow arrangements
9. To determine Stefan Boltzmann constant

COURSE OUTCOMES:

- 1. The student should be able to prepare technical reports and documents detailing the experimental methodology.**
- 2. Determine the time period of a simple and compound pendulum and visualize the basic characteristics of a simple harmonic motion.**
- 3. Determine the mass moment of inertia (ROG) of irregularly shaped objects using bifilar and trifilar suspensions.**
- 4. Analyze the free and forced vibration characteristics of an equivalent spring mass system and determine its frequency response function.**

1. Determine the time period of a simple pendulum. Verify that the time period is independent of the mass of the bob.
2. Determine the radius of gyration of a compound pendulum.
3. Determine the radius of gyration of a given bar by using a Bifilar suspension.
4. Study the undamped free vibration of an equivalent spring mass system.
5. Study the forced vibration of an equivalent spring mass system.
6. Study the torsional vibration of a single rotor shaft system.
7. Determine the frequency response function of an equivalent spring- mass- dashpot system.
8. Pressure profile measurement on Journal bearing.

Semester-VI

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET351	Production Engineering	3	1	0	4	4
2.	MET352	Mathematical Methods	3	0	0	3	3
3.	MET353	Control Systems	3	1	0	4	4
4.	MET354	Fluid Mechanics - II	3	1	0	4	4
5.	MET3XX	Elective - I	3	1	0	4	4
6.	MEL361	Applied Thermodynamics Lab	0	0	2	2	1
7.	MEL362	Industrial Engineering – I Lab	0	0	2	2	1
8.	MES363	Seminar	0	0	4	4	2
9.	MEI364	Industrial Training	-	-	-	-	2
						Total Credits	25

Subject: Production Engineering (Code: MET351)	Year & Semester: B. Tech Mechanical Engineering 3rdYear & 6thSemester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, a student should be able to:

CO1: Determine the shear angle and cutting force in machining and understand the basics of metal cutting.
CO2: Estimate tool life and explain the tool wear mechanisms and abrasive machining process.
CO3: Analyze the forming process behavior for conventional and advanced metal forming processes.
CO4: Understand the basics of limits, fits and tolerances in manufacturing.

Detailed Syllabus:

UNIT I

Introduction to machining; Orthogonal cutting; Oblique cutting; Types of chips; Mechanics of chip formation; chip breakers; Mechanics of Metal Cutting: Merchant's circle diagram; Determination of cutting and thrust forces; Coefficient of friction; strain rate; Measurement of shear angle, Thermal aspects of machining, Numerical problems.

UNIT II

Mechanisms of tool wear; Types of tool wear, Tool life: Variables affecting tool life-Cutting conditions; Tool angles specification systems; Tool materials; Desirable Properties of Cutting Tool; Determination of tool life; Machinability, Economics of machining.
Abrasive Machining Process: Introduction; Grinding: Characteristics of a grinding wheel; Specification of grinding heels; Mechanics of grinding process; Grinding operations; Wheel wear; Surface Finish; Selection of grinding wheels.

UNIT III

Metal Forming: Hot and cold working, Rolling; Forging; Extrusion; Sheet metal working. Introduction to high energy rate forming processes, their advantages and application. Electromagnetic forming, Explosive forming, Electrohydraulic forming.

UNIT IV

Metrology: Introduction to Metrology, Accuracy and Precision. Limits, fits and tolerances, need of providing tolerance, unilateral and bilateral system, Taylor's principles of gauge design, Sine bars and gauge blocks manufacturing method and their applications, Numerical problems.

Text Book:

1. Manufacturing Science-A. Ghosh and A.K. Malik, Affiliated East Press, New-Delhi.

Reference Book:

1. Campbell, J.S., Principles of Manufacturing Materials and Processes, McGraw-Hill, New-York,
2. Engineering Metrology and Measurements by N.V. Raghavendra and L. Krishnamurthy, 1st Edition, Oxford University Press
3. Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
4. Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston

COURSE OUTCOMES:

1. Able to solve non-linear equations using, R.F, Newton Rapson methods.
2. Able to solve linear system of equations using Gauss elimination, Gauss-Jourdan, Gauss siedel & LU decomposition
3. Able to use interpolation formulas; and linear & non linear curve fitting.
4. Able to use numerical differentiation & integration methods. Solve ODEs & PDEs using numerical methods.
5. Able to develop computer programmes for the above methods and interpret them graphically.

UNIT I

Flow charts. Computer languages. Constants and variables. Arithmetic expressions. Input/output, control statements. Introduction to programming. Types of errors. Computational algorithms and computer arithmetic. Iterative methods. Solution of equations: Bisection method, Regula-falsi method, Newton Raphson method. Solution of linear system of equations: Gauss elimination, Gauss-Jordan, Gauss- Siedel method, LU decomposition.

UNIT II

Interpolation and approximation of functions, Newtons forward formula (equal and unequal intervals) Curve fitting (straight line, nonlinear, exponential) differentiation, integration (Trapezoidal/Simpson's rule, Weddle's) and program.

UNIT III

Numerical solution of ordinary different equations. Runge- Kutta methods, Types of PDEs, boundary value problems, solution of parabolic PDEs using finite differences and program.

- Examples to be taken from Mechanical engineering applications.

Text Book:

1. Sastry, S. "Numerical Methods", *Printice Hall of India, New Delhi*.
2. Chapra & Chapra Numerical methods for Engineers. Mc. Graw Hill.

Reference Books:

1. Veerarajan, "Numerical Methods", *Tata Mc-GrawHill, New Delhi, 2000*.

COURSE OUTCOME:

- 1. Develop the mathematical models of LTI dynamic systems, determine their transfer functions, describe quantitatively the transient response of LTI systems, interpret and apply block diagram representations of control systems and understand the consequences of feedback.**
- 2. Use poles and zeroes of the transfer functions to determine the time response and performance characteristics and design PID controllers using empirical tuning rules.**
- 3. Determine the stability of linear control systems using the Routh-Hurwitz criterion and classify systems as asymptotically and BIBO stable or unstable.**
- 4. Determine the effect of loop gain variations on the location of closed-loop poles, sketch the root locus and use it to evaluate parameter values to meet the transient response specification of closed loop systems.**
- 5. Define the frequency response and plot asymptotic approximations to the frequency response function of a system. Sketch a Nyquist diagram and use the Nyquist criterion to determine the stability of a system.**

UNIT I

Introduction: Concept of automatic control, open loop and closed loop systems, servo mechanism, block diagram, transfer function.

Representation of control components and systems: Translation and rotational mechanical components, electrical components -series and parallel combinations, comparators for rotational and linear motions, integrating devices, hydraulic servomotor temperature control systems, speed control systems.

UNIT II

System response: First and second order systems, response to step, pulse, ramp and sinusoidal inputs, systems with distance velocity lag.

Modes of controls: Proportional control, Proportional pulse reset control, proportional pulse rate control, proportional reset rate control, two position control.

Controller Mechanism: Pneumatic, hydraulic and electric controllers, general principles and circuits for generating various control actions.

UNIT III

Control system analysis: Transient response of simple control systems, stability of control systems, Routh's criterion. Frequency response analysis, polar rectangular and logarithmic

plots, experimental determination of frequency response, Bode and Nyquist stability criteria, gain and phase margins. Root locus plots of simple transfer function, transient response from root locus.

Electronic Analogue computers: Elements of analogue computers, solution of simple differential equations.

Text Book:

1. Ogata, K., "Modern Control engineering", *Prentice Hall of India, 3rd edition, New Delhi, 1997.*

Reference Book:

1. Raven, F., "Automatic Control" *McGraw Hill Int., 1999.*

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

CO1	Understand the working of gas turbine plant components and analyse their performance.
CO2	Differentiate ideal and practical gas turbine cycles.
CO3	Analyze the operations of centrifugal air compressor and axial air compressor.
CO4	Design the working proportions of hydraulic machines.

Unit-I

Review of Basics: Introduction to Prime Movers, Gas Turbines, Review of Basic principles - Thermodynamics, Review of Basic principles - Fluid Dynamics and Heat Transfer, Fundamentals of Rotating Machines - Energy Equation, Dimensional Analysis, Aerofoil Theory.

Ideal Gas Turbine Cycles: Analysis of Ideal Gas Turbine Cycles, Simple Cycle, Regeneration Cycle, Reheat Cycle, inter cooling Cycle.

Practical Gas Turbine Cycles: Analysis of Practical Gas Turbine Cycles, Methods of accounting for component losses, Efficiencies, change in the composition of the working fluid. Combustion Chambers: Gas turbine combustion systems - Introduction, Geometry, Factors affecting Design & Performance, Requirements of the Combustion Chamber, Gas Turbine Combustion Emissions.

Unit-II

Centrifugal Compressors: Centrifugal Compressors- Principle of Operation, T-s diagram, Energy equation, velocity triangles, types of blades. Analysis of Flow, Performance Characteristics.

Axial Flow Compressors: Axial Flow Compressors - Construction, Principle of Operation, T-s diagram, Energy equation, velocity triangles. Analysis of Flow. Work done factor, Stage efficiency, Degree of reaction, Performance characteristics.

Unit-III

Hydraulic Turbines: Principle of impingements of jets, Euler equation, classification of Hydraulic Turbines, Constructional Details, Analysis, Efficiencies & Design Parameters of Impulse (Pelton Turbine) and Reaction Turbines (Francis, Kaplan & Propeller Turbine), Draft Tube, Cavitation, Governing of Hydraulic Turbines, Characteristics of the Hydraulic Turbine

Unit-IV

Centrifugal pumps: Advantages of Centrifugal Pumps over Reciprocating Pumps, Construction and Working of a Centrifugal Pump, Classification of Centrifugal Pumps, Different Heads of Centrifugal Pumps, Different Efficiencies of a Centrifugal Pump, Analysis of a Centrifugal Pump, Minimum Starting Speed of a Centrifugal Pump, Maximum Suction Lift and Net Positive Suction Head, Cavitation, Priming, Pumps in Series and in Parallel

Fluid System: Hydraulic press, Hydraulic accumulator, hydraulic intensifier, Fluid coupling, torque convertor, hydraulic ram, hydraulic actuator, airlift pump.

Reading:

1. Ganesan, V., Gas Turbines 3/e, Tata McGraw Hill Book Company, New Delhi, 2010.
2. Vasandani, V.P. and Kumar, D.S., Treatise on Heat Engineering, Chand and Co Publishers, New Delhi, 2011.

3. Saravanmuttoo, H.I.H., Rogers, G.F.C. and Cohen H., Gas Turbine Theory, 6/e. Pearson Prentice Education, 2008.
4. Applied Thermodynamics for Engineering Technologists 5th Edition (English, Paperback, Eastop T.D.).

MET3XX

ELECTIVE-1

CLT (4 3 1)

Course No.: MET 355

FINITE ELEMENT METHOD

C L T (4 3 1)

Course Outcomes: Upon successful completion of this course students should be able to:

- 1. Understand the concepts behind formulation methods in FEM.**
- 2. Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.**
- 3. Develop element characteristic equation and generation of global equation.**
- 4. Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow problems and solve them & find displacements, stress and strains induced.**

UNIT I

Basic Concept, Historical background, Engineering applications, general description, Comparison with other methods. Need for weighted-integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach.

UNIT II

Model boundary value problem, finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials.

UNIT III

External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, computer programs.

Variational approach, Galerkin approach, one-dimensional and two-dimensional steady-state problems for conduction, convection and radiation, transient problems.

Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, Solution of incompressible and compressible fluid film lubrication problems.

Text Books:

1. Logan, D. L., A first course in the finite element method, 6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergamon Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.
2. Bathe K. J. Finite Elements Procedures, PHI. 2. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

Course No.: MET 356 ADDITIVE MANUFACTURING PROCESSES C L T (4 3 1)

COURSE OUTCOMES: At the end of this course, the students shall be able to:

1. Understand the basics of additive manufacturing (AM) and working principles of different AM processes.
2. Explore the applications of different AM processes in various fields.
3. Analyze various AM processes to understand their relative merits and demerits.
4. Design and develop functional models using different AM techniques.

Unit-I

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, AM vs traditional manufacturing, advantages and limitations of AM over conventional manufacturing, nomenclature of AM machines, prototyping, tooling and manufacturing. Classification of AM processes, common AM processes, generalized AM process chain and steps in AM, types of materials for AM.

Unit-II

Vat Photo polymerization AM Processes: Introduction, materials for AM processes utilizing Vat Photo polymerization, Stereo-lithography (SL), photo polymerization process, process modeling, variants and classification of VAT photo polymerization process, Advantages and drawbacks of vat photo polymerization processes.

Powder Bed Fusion (PBF) AM Technique: Introduction to PBF, materials, powder fusion mechanism, process parameters and modeling, powder handling, powder fusion techniques, PBF process variants, Advantages and drawbacks of PBF.

Extrusion Based AM Processes: Introduction, basic principles of extrusion-based processes, Fused Deposition Modeling (FDM), materials, Bio extrusion, Contour Crafting, Non-Planar systems, RepRap FDM systems, process benefits and drawbacks.

Unit-III

Material Jetting (MJ) and Binder Jetting (BJ) AM Processes: Introduction to MJ and BJ, materials, process description to MJ and BJ, variants of MJ and BJ, comparison between MJ and BJ, benefits and drawbacks.

Sheet Lamination AM Processes: Introduction, Variants of sheet lamination, Laminated Objected Manufacturing (LOM), Ultrasonic additive manufacturing (UAM), benefits and drawbacks of UAM.

Directed Energy Deposition (DED) AM Processes: Introduction to DED, process description, classification of DED techniques, benefits and drawbacks of DED.

Recommended Texts:

1. Manu Srivastava, Sandeep Rathee, Sachin Maheshwari, TK Kundra, “Additive Manufacturing: Fundamentals and Advancements”, 1st ed.2019, Boca Raton: CRC Press, Taylor & Francis group.
2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2nd Edition, Springer, 2015.

Recommended References:

1. Sandeep Rathee, Manu Srivastava, Sachin Maheshwari, TK Kundra, Arshad Noor Siddiquee, “Friction Based Additive Manufacturing Technologies: Principles for Building in Solid State, Benefits, Limitations, and Applications”, 1st ed.2018, Boca Raton: CRC Press, Taylor & Francis group.
2. Chua Chee Kai, Leong Kah Fai, “3D Printing and Additive Manufacturing: Principles & Applications”, 4th Edition, World Scientific, 2015.
3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
4. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Course No.: MET 357**Advanced Thermodynamics****C L T (4 3 1)**

Subject: Advanced Thermodynamics (Code: MET3XX)	Year & Semester: B. Tech Mechanical Engineering 3rd Year & 6th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

After the completion of course, students will be able,

CO1	To extend the in-depth knowledge in the application of the laws of thermodynamics
CO2	To apply concepts of entropy generation and exergy to practical applications/systems
CO3	To have a coherent knowledge about the evaluation of the thermodynamic properties
CO4	To identify, formulate and solve a wide range of real world problems involving energy transfer

Unit 1

Scope and methods of thermodynamics, Review of Thermodynamics, Mathematical background, Macroscopic and Microscopic approaches in thermodynamics, Energy and first law of thermodynamics, First law for closed and open systems, Broadening understanding of energy transfer by work and heat, Structured presentation of First law of Thermodynamics.

Unit 2

Second law of thermodynamics, Traditional formulation of Second law of thermodynamics, logical relation between alternative statements of the second law, Mathematical formulation of second law of thermodynamics, Entropy maximum and Energy Minimum principle, Born-Caratheodory formulation of second law.

Unit 3

Entropy Generation, Concept of Exergy of system, Exergy balance of closed and open systems, Second Law efficiency (of heat engines, heat pumps, refrigerators, work producing and consuming devices, heat exchangers), Thermoeconomics, Exergy account of a vapour power plant (Case study), Thermodynamics of a Biological System.

Unit 4

Thermodynamic properties of pure fluid, ideal gas properties, State relationships for real gases and liquids, Two-constant and Multiconstant Equation of state, Virial Equations, Vander Waals Equation of State, Redlich-Kwong Equation of state, Compressibility charts, Generalized Equation of state, Maxwell's relations, Generalized relations, Evaluation of Thermodynamic properties, p-v-t relations for gas mixtures, Multicomponent systems, Chemical potential (Fugacity).

Textbooks:

1. Bejan, A., "Advanced Thermodynamics" John Wiley & Sons, 2006.
2. Moran, M.J., Shapiro, H.N., Boettner, D.D., Bailey, M.B., "Principles of Engineering Thermodynamics", Wiley India, 2017.

Reference Books:

1. Kestin, J., "A Course in Thermodynamics", McGraw Hill, 1979.
2. Wark, K., "Advanced Thermodynamics", McGraw Hill, 1995.

MEL361	APPLIED THERMODYNAMICS LAB	0-0-2	Credits: 1
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Prerequisites: Thermodynamics, Fluid Mechanics, Applied Thermodynamics, Hierodulic machines

Course Outcomes: At the end of the course, the student should be able to:

CO1: To investigate the performance and emission testing of SI Engine.

CO2: To investigate the performance and emission testing of CI Engine.

CO3: To acquire knowledge of working principle of compressors.

CO4: To gain knowledge of Turbines,

List of Experiments:

1. Study of different internal combustion engine models.
2. Experimental study of characteristic performance curves & emission of spark ignition engine using gasoline as fuel.
3. Experimental study of characteristic performance curves & emission of compression ignition engine using diesel as fuel.
4. Study of working of compressors using different compressor models.
5. Experimental study of characteristic performance curves of single cylinder reciprocating compressors.
6. To study the constructional details of hermetically sealed reciprocating compressor.
7. Study of the Pelton wheel Turbine.
8. Study of the Francis Turbine.

COURSE OUTCOMES:

- 1. Demonstrate human factors/ergonomic principles (HF/E) that influence the design, performance and safety of work systems.**
- 2. Apply HF/E guidelines and use standard HF/E in the design of work systems.**
- 3. Model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activity charts, block diagrams, and process maps, for purposes of work system documentation, analysis, and design.**
- 4. Determine the time required to do a job using standard data, occurrence sampling, time study, and predetermined time systems.**

1. Ergonomic design study (Present/proposed/new) of a product, equipment or work environment (human-machine interface) – (This involves about four to five laboratory classes / sessions)
2. To assembly a product (electrical holder, etc.), record the cycle time and draw learning curve of the operator performing the assembly.
3. Draw Out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
4. Study and draw of flow process charts (some suitable assembly operation)
5. Study and draw multi activity chart of a suitable method and propose better method/s.(Man and machine)
6. Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
7. To calculate the standard time of a suitable job, using predetermined time standard techniques.

CO1	Review literature on a given advanced topic related to the specific stream.
CO2	Summarise the concept of the chosen topic systematically after considerable study of the content from primary as well as secondary sources
CO3	Learn and present the structure and format of technical reports as per specified norms
CO4	Interpret graphs of various kinds and discuss the concept & conclusion in an open seminar.

CO1	To study the concept of Facility, Location & Layout & implement in their Industrial training Project work.
CO2	An understanding of the impact of engineering solutions and industrial safety in a global and social context.
CO3	Develop the ability to work as an individual and in group with the capacity to be a leader or manager as well as an effective team member.
CO4	Demonstrate competence in mechanical engineering fields through problem identification, formulation and solution.

Semester-VII

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET401	Mechatronics and Measurement Systems	3	1	0	4	4
2.	MET402	Industrial Engineering - II	3	1	0	4	4
3.	MET403	Machine Design	3	1	0	4	4
4.	MET4XX	Elective-II –(Design, Ther. & Pro.)	3	1	0	4	4
5.	MET4XX	Elective-III–(Design, Ther. & Pro.)	3	1	0	4	4
6.	MEL411	Mechatronics and Measurement Systems Lab	0	0	2	2	1
7.	MEL412	Industrial Engineering – II Lab	0	0	2	2	1
8.	MEP413	Major Project – Stage I	0	0	6	-	3
Total Credits							25

Course Code: MET 401 Mechatronics and Measurement Systems C L T (4 3 1)

Mechatronics and Measurement Systems

COURSE OUTCOMES:

- CO1 Identify and develop operational research models from the verbal description of the real system.
- CO2 Understand the mathematical tools that are needed to solve optimisation problems.
- CO3 Use mathematical software to solve the proposed models.
- CO4 Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

UNIT I

Measurement and Instrumentation; definitions, significance, Fundamental methods, generalized measurement system, Functional elements, Types of input quantities, standards, calibration, uncertainty, Errors, Classification of instruments, Input-output configuration, Interfering and modifying inputs, methods of correction, Generalized performance characteristics, static characteristics, static calibration, Dynamic characteristics, zero and first order instruments, time constant, Second-order instruments, transient response characteristics. Relative and absolute motion devices, relative displacement, Resistive potentiometers, bridge circuit, LVDT, Variable inductance and variable capacitance pick-ups, Piezoelectric transducers, fibre optic displacement transducer, Resistance strain gage, Relative velocity-translational and rotational, Mechanical revolution counters and timers, stroboscopic method, Moving coil and moving magnet pickups, DC and AC tachometers, Eddy current drag-cup tachometer, acceleration measurement.

UNIT II

Hydraulic and pneumatic load cells, flapper nozzle principle, Force transducers with elastic members, Proving ring transducer, cantilever beam transducer, electromagnetic balance, Dynamometers – Absorption, driving and transmission type, reaction forces in shaft bearings, prony brake, eddy current brake dynamometer, Instruments for high, mid and low pressure measurement, dead weight and null type, Elastic element gages, Differential pressure cell, high pressure measurement, Low pressure measurement –, Pirani gages & McLeod pressure gauge.

UNIT III

Orifice meters, Venturimeter, Pitot tube, Flow nozzle, Variable area meters, rotameter, design and accuracy, Positive displacement flow meter, turbine flow meter, Electromagnetic flow meter, ultrasonic flow meters, Temperature sensing techniques, liquid-in-glass and bimetallic thermometers, Pressure thermometers, electrical resistance thermometers, Thermistors, Thermocouples, thermopiles, Radiation pyrometers, Optical pyrometer.

Text Book:

1. Beckwith, B., “Mechanical Measurements”, 6th edition, *Pearson Education Int.*, 2008.

Reference Book:

1. Nakra B.C. “Instrumentation, Measurements & Analysis”, 2nd edition, *Tata McGrawHill, N.Delhi*, 2008.
2. Doebelin, E.O., “Measurement systems”, 5th edition, *McGraw Hill, New Delhi*, 2004.

INDUSTRIAL ENGINEERING – II

COURSE OUTCOMES:

1. Grasp the concept of organizational design with emphasis on organization principles & work design.
2. Analyse & design facility location and layout using various techniques and softwares.
3. Demonstrate the ability to use the methods of statistical quality control and process control for effective designing of Industrial Quality Monitoring Systems.
4. Demonstrate the ability to apply the techniques of material management and inventory control for effective designing and systematic implementation of various MM methods and inventory systems in manufacturing set-up.

UNIT I

Factory organization: Introduction to Plant organization, Principles of Organizational structure, Organization charts, Types of Organizations, Developing an organization structure, Results of good organization,, Informal organization, advantages and disadvantages.

Location and Layout analysis: Introduction to Facility location problems, Factors affecting the plant location. Break even analyses and their application, Subjective, qualitative and semi- Quantitative techniques of facility location, Single facility Location problem, Minimax Location problem, Gravity problem and their applications. Line balancing, Introduction to facility layout and their objectives, Classification of Layouts, with advantages and disadvantages of each, Layout design procedures(CRAFT,CORELAP,ALDEP), Material handling systems, Make or Buy decisions, Planning and control of Batch Production,. Characteristics of Batch Production, Determination of Batch size, Minimum Cost batch Size, Maximum Profit Batch size, Sequencing and scheduling for Batch Production, Line of Balance technique.

UNIT II

Inspection and quality control: Concept and Definition of Quality, Concepts of Inspection and quality control, Objectives of inspection, Function of Inspection and their types, Concept of statistical quality control (SQC), Process variation, Sampling inspection. Concepts and types of Control charts, Acceptance sampling, application of control charts and sampling plans.

UNIT III

Materials management and inventory control: Integrated materials management and their components, Functions and objectives of material management, Introduction and concepts of Inventory management, Purchase model with instantaneous replenishment and without shortage, Manufacturing model without shortages, Purchase model with shortages, Manufacturing model with shortages, Probabilistic inventory concepts with lead time., Selective inventory management- ABC , FSN, VED analyses.

Text Book:

1. Everett, E.A., Ronald J.E, “Production and Operations Management”
Prentice Hall of India, 5th edition, New Delhi, 2001.

Reference Books:

1. Claude, S.G., “Management for Business & Industry” *Prentice Hall of India*, New Delhi, 2000.
2. Everett, E.A., Ronald J.E, “Production and Operations Management”, *Prentice Hall of India, 5th Edition, New Delhi, 2001.*
3. Grant, E.L; Leavenworth R.S, “Statistical Quality Control”, *Tata Mcgraw Hill, 7th Edition*, New Delhi, 1996.
4. Apple, J.M, “Plant Layout & Material Handling”, *John Wiley & Sons, New York.*
5. Maynard, Industrial Engineering Hand Book, *McGraw Hill, New York.*

MACHINE DESIGN

COURSE OUTCOME:

1. Analyse the stress and strain of mechanical components.
2. Demonstrate knowledge of basic machine elements used in machine design.
3. Design machine elements to perform functions in order to obtain desired objectives under various operating conditions.
4. Conduct a failure analysis for the design of mechanical components to select the suitable materials and manufacturing considerations.

UNIT I

Design of friction elements, various types of brakes, design equations for various types of brakes, design analysis of all types of brakes, e.g., band brake, long shoe brake, etc. design analysis of all types of clutches, design of couplings and keys for shafts, etc, design and analysis of flat and V-belt, equations for power, slip, etc, design of chain drive.

UNIT II

Introduction to gear design, design of spur gear, equation for σ_b and σ_c for spur gear, design analysis for bending, force analysis for Helical gear, design analysis for helical gear, design of bevel gear, determination of bearing forces, horizontal and vertical shafts, design analysis for bevel gear , design analysis for worm gear.

UNIT III

Introduction to Plain bearings, Bearing surface at Micro level, Derivation of Energy equation and PV factor , PV graph, Values of PV , Derivation of Wear coefficient equation, Step-by-step procedure for Plain bearing design, Self lubricating bearings and use of clearance for life of bearing, Design of Hydrodynamic bearings, Derivation of Reynolds equation for three dimensional case, Journal bearing geometry, Variation of viscosity with pressure and temperature, Viscosity index, Sommerfeld number, Analysis of h_o , h_{min} , Q_{in} , Q_{loss} , T_{in} , T_{out} , Introduction to Rolling element bearings, Design of AFB (??) , Equations for L_{10} life, Static loading and dynamic loading ,Use of AFB catalogue, Determination of Load based on radial and thrust load for ball bearings, Derivation of Load equation for Tapered AF bearings, Design analysis on the basis of loads and selection of AFB from a catalogue.

Text Books:

1. Mot, R.L., “Machine Elements in Mechanical Design”, *Maxwell Macmillan Intl. edition N.York , USA, 1992.*
2. Shigley, J.E., “Machine Engineering Design”, *McGraw Hill, higher education,2004.*

Reference Books:

Shigley, J.E., Mischke, C. Brown T., “Standard Hand book of Machine Design” *McGraw Hill.*

Course No.: MET404 ADVANCED MECHANICS OF SOLIDS C L T (4 3 1)

Course Title: ADVANCED MECHANICS OF SOLIDS

Pre-requisite(s): Strength of Materials

Course Outcomes:

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

CO1 Understand the concept of tensor.

CO2 Analyse advanced concept of stress and strain in structural problems.

CO3 Apply the concept of different elastic functions to solve complex problems.

CO4 Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems.

UNIT 1

Mathematical Preliminaries: Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor. (8 L)

UNIT 2

Analysis of Stress and Strain: Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity. (8 L)

UNIT 3

Problem formulation and solution strategies: Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lamé-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. (8 L)

UNIT 4

Two-dimensional problems: Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method. (8 L)

Text Books:

1. Elasticity, Theory, Applications, and Numerics by Martin H. Sadd
2. Theory of Elasticity by Stephen Timoshenko and J. N. Goodier
3. Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications.

Reference Books:

1. Continuum Mechanics, A.J.M Spencer, Dover Publications, INC
2. Advanced Mechanics of Materials by H. Ford and J. M. Alexander
3. The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science + Business Media, LLC

Course No.: MET 405

Refrigeration and Air Conditioning

Elective II: Thermal

C L T (4 3 1)

Course Outcomes:

1. To Identify the need and importance of various refrigeration and air conditioning cycles, the typical and some advanced and innovative schematic designs, and the goals of R&AC systems.
2. To design the VCRS and VARS with improving performance parameters.
3. To describe the working of different types of air conditioning systems.
4. To evaluate the actual applications of R&AC.

UNIT-I

Introduction

Basics of refrigerator and heat pump, Carnot refrigeration and heat pump, units of refrigeration, COP of refrigerator and heat pump, Carnot COP, Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapor refrigeration system, steam jet refrigeration, thermo- electric cooling, adiabatic demagnetization

Basic Principle of operation of air refrigeration system, Bell Coleman air refrigerator, advantages of using air refrigeration in air craft, disadvantage of air refrigeration in comparison to other cold producing methods, simple air refrigeration in air craft, simple evaporative type, air refrigeration in air craft, necessity of cooling the air craft.

UNIT-II

Vapor Compression refrigeration system

Simple vapour compression cycle, Methods of improving COP, flash chamber, flash inter cooler, optimum inter stage pressure for two stage refrigeration system, single expansion and multi expansion cases, basic introduction of single load and multi load systems, cascade systems, Nomenclature of refrigerants.

Vapor absorption refrigeration system and special topics

Basic absorption system, COP and maximum COP of the absorption system. Actual NH₃ absorption system, function of various components, Li-Br absorption system, Selection of refrigerant and absorbent pair in vapor absorption system, Electro-Lux refrigerator, comparison of compression and absorption refrigeration system, , desirable properties of refrigerants, cold storage and Ice Plants.

UNIT-III

AIR CONDITIONING

Psychrometric properties of moist air, By- pass factor of coil, sensible heat factor, ADP of cooling coil, Air washer. Air conditioning systems: Classification, factors affecting air conditioning systems, comfort air conditioning system, winter air conditioning system, summer Air Conditioning system, year-round air-conditioning system, unitary air conditioning system, central air conditioning system, Room sensible heat factor, Grand sensible heat factor, effective room sensible heat factor, Industrial application of Air conditioning.

Text Books:

1. Refrigeration and Air Conditioning - C.P. Arora, Tata McGraw-Hill
2. Refrigeration and Air- Condition by W. Stoecker Mc Graw Hill

Reference Books:

1. Basic Refrigeration and Air Conditioning- Ananthana and Rayanan, McGraw-Hill
2. Refrigeration and Air Conditioning- Arora and Domkundwar, Dhanpat Rai.

Course No.: MET406

**Material Testing, Inspection and
Characterization**

Elective II: Production

C L T (4 3 1)

COURSE OUTCOMES:

By successful completion of this course, the student will be able to

1. Understand various destructive and non destructive methods of testing materials.
2. Explain the principles of metallurgical microscope, X-ray Diffractometer (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Thermal analysis and dilatometer.
3. Describe the various sample/specimen preparation techniques for XRD, SEM, TEM and thermal analysis and quantitative metallography.
4. Apply knowledge to select appropriate tool to characterize the material by knowing its merits and demerits.

UNIT I

Purpose and importance of destructive tests – Concepts, and method of Tensile, hardness, bend, torsion, fatigue and creep testing.

UNIT II

Purpose and limitations of NDT, Concepts, operating principles, liquid penetrant test, magnetic particle testing, eddy current testing, ultrasonic testing radiography, acoustic emission, thermal imaging method. Comparison of NDT methods and selection of NDT methods.

UNIT III

Tools of characterisation - Light microscopy, basic principles and special techniques. X-ray diffraction and its applications in materials characterization.

Electron microscopy, Construction, operation and applications of scanning electron microscope (SEM), transmission electron microscope (TEM)

UNIT IV

Thermal analysis: Thermo gravimetric analysis, differential thermal analysis, differential scanning calorimetry & dilatometry.

TEXT BOOKS:

1. Non-destructive testing, B.Hull And V.John, Macmillan, 1988.
2. Modern Physical Metallurgy and Materials Engineering, R. E. Smallman, R. J. Bishop, sixth edition, Butterworth-Heinemann, 1999.
3. Materials Characterisation, P.C.Angelo, Elsevier (India) Pvt. Ltd, Haryana, 2013,

Course No.: MET407

BASIC FRACTURE MECHANICS

Elective III: Design :-

C L T (4 3 1)

BASIC FRACTURE MECHANICS

COURSE OUTCOMES:

1. Identify and describe different failure mechanisms in materials and engineering structures.
2. Explain how a crack affect an engineering structure and describe the state of stress and strain that may arise in the vicinity of the crack front in different materials
3. Evaluate fracture toughness for structures with cracks using LEFM and EPFM techniques.
4. Analyze the crack growth in materials subjected to fatigue loads.

UNIT I

Mechanisms of fracture and crack growth, cleavage fracture, ductile fracture, fatigue cracking, Summary of basic problems and concepts in fracture, a crack in a structure, theoretical strength of a material, Inglis's solution, crack tip stresses, the Griffith criterion, Modified Griffith's theory

UNIT II

The elastic crack-tip stress field, Stress Intensity factor, the effect of finite size, Some special cases, elliptic cracks the energy principles, the concept of energy release rate, the criterion for crack growth, the crack resistance, the concept of J-integral, crack opening displacement criterion, K_{IC} and G_{IC} test methods

UNIT III

Crack-tip plastic zone, Irwin's plastic zone correction, The Dugdale approach, Plane stress versus plane strain, plastic constraint factor, the thickness effect, application of von Mises and Tresca yield criteria to obtain plasticity effected regions, Fatigue failure, S-N curve, Crack initiation and propagation, effect of overload, crack closure, Environmental assisted cracking, service failure analysis

Text Book:

1. Anderson T.L., "Fracture Mechanics Fundamentals and applications", CRC, Taylor & Francis, 2005.

Reference Book:

1. Janssen, M. J., Zuidema, J., Wanhill R.J.H., "Fracture Mechanics", Spon Press, 2004.
2. Prashant Kumar, "Elements of Fracture Mechanics", McGraw Hill Education, 2017

Course No.: MET408

Design of Fluid Thermal Systems

C L T (4 3 1)

COURSE OUTCOMES:

After the completion of course, students will be able,

CO1	To understand thermal system engineering design process
CO2	To learn the characteristics of the components of the thermal system and their effects on overall system performance
CO3	To simulate a thermal system and solve for a workable solution
CO4	To identify, formulate and solve a wide range of real world thermal related problems

UNIT 1

Introduction, Design versus Analysis, Synthesis versus Design, Optimal and Nearly Optimal designs, Life Cycle Design, Thermal design aspects, Concept, creation and assessment, Thermal system (Basic Characteristics, Analysis), some typical examples, formulation of the design problem, Steps in design process, Material selection.

UNIT 2

Modelling of thermal systems, types of models, Mathematical modeling, General procedure (Transient/steady state, spatial dimensions, lumped mass approximation, simplification of boundary conditions, negligible effects, idealizations, material properties, conservation laws, simplification of governing equations), final model and validation, physical modeling and dimensional analysis, curve-fitting, Numerical modeling and simulation, Solution procedures, methods for numerical simulation,

UNIT 3

Formulation of problem for optimization, optimized design, objective function, constraints, operating conditions versus hardware, optimization methods (Calculus methods, Search methods, etc.), Optimization of thermal systems, Considerations of Second law of Thermodynamics, Economic analysis, Estimation of total capital cost, principles of economic evaluation, Thermoeconomic analysis and evaluation.

UNIT 4

Applications with Thermodynamics, Heat and Fluid flow, Cogeneration system Exergy analysis, Thermal insulation, Fins, Electronic packages, Refrigeration, Power Generation, Energy Storage by Sensible heating.

Textbooks:

1. Bejan, A., Tsatsaronius, G., Moran, M., "Thermal Design and Optimization", John Wiley, 2013.
2. Stoecker, W.F., "Design of Thermal Systems", McGraw Hill, 2017.

Course No.: MET409

**ADVANCED MANUFACTURING
TECHNOLOGY**

C L T (4 3 1)

ADVANCED MANUFACTURING TECHNOLOGY

Course Outcomes:

- CO1 Identify the use of advanced manufacturing processes in industries and explain the process of micro machining.
- CO2 Identify the need of super finishing processes and understand the process of super finishing.
- CO3 Understand the process of non-conventional forming.
- CO4 Apply knowledge to select appropriate surface processing technique to get the desired surface properties.

UNIT I

Introduction to Advanced manufacturing processes, Advantages of advanced manufacturing processes. Advances in Machining: High speed machining, hard turning. Micro machining: Introduction and need of micro machining, Diamond Micro- grinding/turning, Abrasive Micro machining, Ultrasonic Micromachining, Electric-discharge Micro-machining, Laser Micro-machining, Electrochemical Micro-machining.

UNIT II

Super finishing processes: Introduction to finishing processes, Need and application of superfinishing processes, Abrasive flow finishing, Magnetic Abrasive flow finishing, Magneto rheological abrasive flow finishing.

UNIT-III

Advances in forming: Introduction and application of non-conventional forming, need of non-conventional forming, Electro Magnetic forming, Hydro forming, explosive forming. Advantages of non-conventional forming.

UNIT IV

Surface processing: Introduction and need of surface processing, surface properties, cladding, chemical vapour deposition, physical vapour deposition, shot peening, surface modification by severe plastic deformation. Strategies for improving surface properties.

Text books:

- A. Ghosh and A.K. Malik, Manufacturing Science-, Affiliated East Press, New-Delhi.
- Degarmo, E.P., Black, J.T. and Kohser, R.A, Materials and Processes in Manufacturing, Prentice Hall of India, 2006.

Reference books:

- Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
 - Serop K. Steven, "Manufacturing Processes for Engineering Materials", Prentice Hall of India, 2004
-

CONDUCTION HEAT TRANSFER

COURSE OUTCOME

- CO1** To formulate and solve one dimensional steady state heat conduction problems
- CO2** To formulate and solve two-dimensional steady state and transient heat conduction problems
- CO3** To solve heat conduction problems involving phase change
- CO4** To identify, formulate and solve real world problems related to heat conduction

UNIT I

Introduction, Fourier's law of heat conduction, thermal conductivity, Differential formulation of heat conduction in rectangular, cylindrical and spherical coordinates, General boundary conditions and initial condition, non-dimensional analysis of the heat conduction equation, heat conduction for anisotropic medium, one-dimensional steady state heat conduction, Extended surfaces, Constant area fins, Variable area fins, moving fins, Bessel differential equations and Bessel functions.

UNIT II

Two-dimensional steady state heat conduction, Separation of variable method, Homogeneous differential equations and boundary conditions, Sturm-Liouville boundary value problems, Non-homogeneous differential equations, Non-homogeneous boundary conditions, Method of superposition, Solution to problems in Cartesian and cylindrical coordinates, Unsteady heat conduction, lumped heat capacity system, Non homogeneous equations and boundary conditions, Transient conduction in plates, Transient conduction in cylinders, Transient conduction in spheres, Duhamel's Superposition Integral, Conduction in Semi-infinite regions.

UNIT III

Heat conduction involving phase change, Moving interface boundary condition, non-linearity of the interface energy equation, Simplified model (Quasi-Steady approximation), Exact solutions, Stefan's solution, Solidification of semi-infinite region, Melting of semi-infinite region.

UNIT IV

Heat Transfer in living tissue, Mathematical modeling of vessel-Tissue heat transfer, Microscale heat conduction, physics of energy carriers, Limitations of Fourier's law, Hyperbolic heat conduction, Solutions and approximations for the microscale heat transfer, Inverse heat transfer, parameter estimation, applications to heat transfer, method of sensitivity coefficients, Least squares approach, linear and non-linear inverse problems.

Textbooks:

1. Jiji, L.M., "Heat Conduction", Springer, 2009.
2. Kakac, S., Yener, Y., Naveira-Cotta, C.P., "Heat Conduction", CRC Press, 2018.

Reference Books:

1. Ozisik, M.N., Hahn, D.W., "Heat Conduction", John Wiley, 2012.
2. Muralidhar, K., Banerjee, J., "Conduction and Radiation", Naraosa Publishing House, 2010.
3. Poulidakos, D., "Conduction Heat Transfer", Prentice Hall, 1993.

Course No.: MEL411

MECHATRONICS LAB.

C L T (1 2)

MECHATRONICS LAB.

COURSE OUTCOME:

1. Identify and use basic modern tools for measurement of electrical and electronic signals.
2. Identify and use different types of sensors and actuators for designing a mechatronic product.
3. Design basic circuits utilizing modern electrical and electronic components including operational amplifiers and integrated circuits.
4. Write basic microcontroller programs for controlling a mechatronic product.

LIST OF EXPERIMENTS

1. Sensor/Actuator - Interfacing, calibration, frequency domain characterization, MATLAB serial interface, and serial LCD display
2. Design of electropneumatic circuits for L (??) and square cycles using PLC's.
3. Sorting of components on an intelligent a conveyor system.
4. Modelling of DC Motor System.
5. DC Motor position tracking.
6. DC Motor position set-point control via PID controller, using relay automatic tuning technique7.
7. Dissection of an existing system.
8. Demonstration of recent projects on Mechatronics.
9. Mini Project on Independent modeling, analysis, and design of a mechatronic control system (Select one “mechatronic plant” from the Quanser, rotary family).

Course No.: MEL412

INDUSTRIAL ENGINEERING-II LAB

C L T (1 2)

INDUSTRIAL ENGINEERING-II LAB.

COURSE OUTCOMES:

1. Present a numerical and graphical characterization of quantitative data assuming the quantitative data are observations from a normal distribution to compute the Probability of specific numerical outcomes. Construct and interpret normal Probability plots of quantitative data.
2. Construct, implement and interpret X-bar and R control charts for variables from Standards and from data; and demonstrate how to use the corresponding OC curves.
3. Construct, implement and interpret p, c, and u control charts for attributes from Standards or data; and demonstrate how to use the corresponding OC curves.
4. Demonstrate and simulate layouts to determine optimum material flow rate and cycle time of a job using witness software.

List of experiments:

1. To study the layout of a shop in an organization and draw existing and proposed layouts.
2. To measure the variable characteristics (diameter of pins, with micrometer) and prepare a frequency histogram. Calculate values of X bar and sigma.
3. Verify that when random samples are taken from a lot with a certain percentage of defective, same %age lands to appear in random sampling by using Shewart's kit.
4. Simulate an inspection situation with the help of a Schewhart's bowl and plot X bar, and R charts using computed data.
5. To conduct Process capability study of a machine tool and to specify the tolerances for a job.
6. To verify the theorem "the standard deviation of the sum of any number of independent variables is the square root of the sum of the squares of the S.Ds of the independent variable. Determine statistically, the permissible tolerance of mating components, when the tolerance of the assembly is given.
7. To draw control chart for percent defectives after inspecting a sample and sorting out the defective units.

Course No.: MEP413

MAJOR PROJECT – Stage 1

C L T (3 0 0)

- CO1** Identify a topic in advanced areas of Mechanical Engineering.
- CO2** Review literature to identify gaps and define objectives & scope of the work.
- CO3** Generate and implement innovative ideas for social benefit.
- CO4** Develop prototypes/models, experimental set-up and software systems necessary to meet the objectives.

Semester-VIII

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MET451	Operations Research	3	1	0	4	4
2.	MEL4XX	Elective-IV–(Design, Ther. & Pro.)	3	1	0	4	4
3.	MEL4XX	Elective-V–(Design, Ther. & Pro.)	3	1	0	4	4
4.	MEL4XX	Elective-VI–(Design, Ther. & Pro.)	3	1	0	4	4
5.	MEP463	Major Project – Stage II	0	0	18	-	9
Total Credits							25

Course No.: MET 451

Operation Research

C L T (4 3 1)

OPERATION RESEARCH

COURSE OUTCOMES:

1. Illustrate knowledge of fundamental concepts about operation research.
2. Compare and categorize the knowledge of different approaches to operational performance improvement.
3. Appraise the ability to work effectively in a team and in group and use of business tools.
4. Outline the various Japanese techniques for justify the knowledge and performance improvement in industrial cost control.

UNIT I

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Simplex Method, Graphical solution of LPP., Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions.

UNIT II

Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.

UNIT III

Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem. Sequencing models. Solution of Sequencing Problem – Processing and Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

UNIT IV

Inventory models. Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.

Replacement Models. Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.

TEXT BOOKS:

1. P. Sankara Iyer, "Operations Research", Tata McGraw-Hill, 2008.
2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education, 2005.

REFERENCE BOOKS:

1. J K Sharma., "Operations Research Theory & Applications , 3e", Macmillan India Ltd, 2007.
2. P. K. Gupta and D. S. Hira, "Operations Research", S. Chand & co., 2007.
3. J K Sharma., "Operations Research, Problems and Solutions, 3e", Macmillan India Ltd.
4. N.V.S. Raju, "Operations Research", HI-TECH, 2002.

THEORY OF THIN PLATES AND SHELLS

Course Outcomes:

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

1. Use analytical methods for the solution of thin plates and shells.
2. Use analytical methods for the solution of shells.
3. Apply the numerical techniques and tools for the complex problems in thin plates.
4. Apply the numerical techniques and tools for the complex problems in shells.

UNIT I

Introduction: Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle of Virtual Work, Boundary Conditions.

UNIT II

Static Analysis of Plates: Governing Equation for a Rectangular Plate, Navier Solution for Simply- Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions.

UNIT III

Circular Plates: Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Co-ordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple Cases in Rectangular Plates.

UNIT IV

Static Analysis of Shells: Membrane Theory of Shells- Cylindrical, Conical and Spherical Shells, Shells of Revolution with Bending Resistance - Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels. Thermal Stresses in Plate/ Shell

Text books:

- Theory of Plates and Shells, Timoshenko S. and Krieger W., McGraw Hill.
- Stresses in Plates and Shells, Ugural Ansel C., McGraw Hill.

References:

- Thin Elastic Shells, Kraus H., John Wiley and Sons.
- Theory of Plates, Chandrashekara K., Universities Press.
- Design and Construction of Concrete Shells, Ramaswamy G.S.

POWER PLANT ENGINEERING

Course Outcomes:

1. Identify the different types of power plants and understand the layout of steam power plant.
2. Understanding of Hydroelectric Power plant and Coordination of different types of power plants.
3. Able to describe the working operations of Nuclear, Diesel, Gas and Steam power plants.
4. To apply & analyses the economics of power plant and able to decides the tariffs for different power plants.

UNIT I

Introduction:- Energy source for generation of electric power. Principle types of power plants, their special features and applications, major power plants in India.

Steam Power Plants :- Selection of site, general layout of the power plant, special features of the modern steam boilers, circulation principle, steam separation and purification, economizers and air pre-heater types and estimation of performance, super-heater and superheat control, feed water heaters, cooling tower , temperature and pressure control. Introduction to hydro electric power plant, types of hydro-electric plant in combination with steam plant, Runoff river plant in combination with steam plant, storage plant in combination with steam or nuclear plant, Coordination of hydro-electric and gas turbine stations, coordination of different types of power plants.

UNIT II

Nuclear Power Plants :- Nuclear fuel, nuclear energy by fission, main components of nuclear reactors, pressurized water, boiling water, liquid metal and gas nuclear reactors.

Diesel Power Plants :- Plant layout , two and four stroke cycle diesel engines, fuel injection, lubrication and cooling systems, supercharging and starting systems. Gas and Steam Turbine combined Cycles:- Simple gas and steam combined cycle power generation.

UNIT III

Economic Analysis of Power Plants and Tariffs :- The cost of electrical energy , selection of types of generating equipment , performance and operating characteristics of power plant , load division among generators , Tariff methods of electrical energy .Combined operation of different power plants :- Advantages of combined working , Load division among power stations , Storage

Text Book:

1. Rajput R.K., “A text book of power plant engineering”, *Laxmi Publication, Pvt. Ltd., New Delhi, 2007.*

Reference Books:

1. Thermal Engineering by Ballaney, Khanna Publisher

Scheme 8th Semester: B. Tech. Mechanical Engineering, Batch 2019 Onwards

2. Thermal Engineering by Domkundar& Arora, Dhanpat Rai
3. Steam Turbine Theory & Practice by Kearton, W.J. Pitman.
4. Power Plant Engineering by Morse
5. Power Plant Engineering by Domkundwar
6. Power Plant Technology by El-Wakil

Course No.: MET 454 **ENTREPREUNERSHIP DEVELOPMENT C L T (4 3 1)**
AND RISK MANAGEMENT

ENTREPREUNERSHIP DEVELOPMENT AND RISK MANAGEMENT

COURSE OUTCOME:

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

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Organize and Manage a Small Business
3. Understand Financial Planning, Control and Strategic Marketing Planning
4. Explain New Product or Service Development and Business Plan Creation

UNIT-1

Introduction to Entrepreneurship: Meaning, Role of Entrepreneur, Entrepreneur Process: different approaches, Motivation for becoming an Entrepreneur. SME Concept, its role, status, prospects and policies for promotion of SMEs. Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices, 11 Contribution of Entrepreneurs: Towards R&D, creates Wealth of Nation & Self prospect with Challenge, Entrepreneur Carrier: Different Stages, Entrepreneur Development Programmers (EDPs).

UNIT-II

Characteristics of Entrepreneurship: Risk taker, Perceptive, Curious, Imaginative, Persistent, Goal setting, Hardworking, Research & Management Skill, Soft skills and Feasibility, Women Entrepreneurship: Opportunities, promotion Hurdles and Prospects of women Entrepreneurs. Factors & Models of Entrepreneurial Development, Social Entrepreneurial Initiative: Solving social Problems, Business plan, Strategic Plan vs Business Plan, Technical and Financial Feasibility study and analysis of projects under self employment scheme including small entrepreneur. The World of Opportunity, Idea versus Opportunity, sources of ideas and idea generation techniques, sources of opportunities, identification and selection of opportunities, the Business Plan, Components of a business plan, How to develop a good business plan?, Role of Entrepreneurial Institutions in Entrepreneurship Development, Various Schemes and Incentives.

UNIT-III

Farm based enterprises for production and post production of Agri-produce: Crops: Cereals, Legumes, Oilseeds; Horticulture crops : Fruits and vegetables; Livestock production : Poultry, Fishery, Medicinal and Aromatic plants. Handlooms & Sericulture; Handicraft, coir, jute & leather Agro-Eco Tourism, Micro entrepreneurial skills development and good production practices, Role of Ministry of MSME, Registration Process of MSME, Emerging Technologies & Business Opportunities in India.

UNIT-IV

Risk Management: Risk Factor, Sensitivity Analysis, Vulnerability Analysis, External Risk, Internal Risk, Environmental Risk. Financial planning . Forecasting inputs and outputs, Components of the financial plan, Bootstrapping , Venture and Growth Capital, Managing a

Micro Enterprise, Human resource development for enterprise growth; delegation, motivation and leadership in microenterprises.

REFERENCE BOOKS

1. Byrd Megginson, Small Business Management An Entrepreneur's Guidebook 7th ed, McGraw-Hill, Irwin
2. N. V. R. Naidu, Naidu I. K, Management and Entrepreneurship. International Pvt Ltd, 01- Jan-2008
3. Frank Martin and Marcus Thompson Palgrave, Social Enterprise Developing Sustainable Businesses Macmillan
4. David R. Stokes, Nicholas Wilson Cengage, Small Business Management and Entrepreneurship Learning EMEA, 2006 - Business & Economics
5. Donald F. Kuratko Cengage, Learning Entrepreneurship: Theory, Process, Practice Business & Economics 14-Nov-2008
6. Timmons, Jerry A., and Spinelli, Stephen, 2009. New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill
7. Carree, M.A., and A.R. Thurik „Impact of Economic Growth,'Hand Book of Entrepreneurship Research, New York:Springer

THEORY OF ELASTICITY

Course Outcomes:

1. Explain the fundamental concept of stress & strain followed by an analytical expression relating the stress & strain in 3-D systems.
2. Apply the compatibility equations & boundary conditions to solve the problems of T.O.E in practices.
3. Analyze the structural members subjected to pure bending using the fundamental concept of stress, strain & elastic behaviours of materials.
4. Apply analytical techniques to predict the effects of stress concentration in simple solids & structural components.

UNIT I

Introduction: Elasticity, stress components of stress and strain, Hooks law. Equations in polar coordinates, Plane stress and plane strain: Strain at a point, Mohr circle for strain rosette, differential equation of equilibrium, boundary conditions, compatibility equations, overview of Airys stress functions.

UNIT II

Two dimensional problems in rectangular coordinates: solution by polynomials, St Venants principles, determination of displacement, bending of beams, solution by Fourier series. Two dimensional problems in polar coordinates: Equations in polar coordinates, equation about 1- axis, and pure bending in curved bars.

UNIT III

Determination of strains and displacement, effect of circular hole on stress distribution in plate concentrated and vertical loading of a straight boundary, circular disc, general solution and its applications, Analysis of stress and strain in three dimensions: stress at a point, principal stress, stress ellipsoid and stress director surface, homogenous deformation, strain at a point, principle strain rotation.

Text Books:

1. Timoshanko, S.P. and Goodier, J.N., "Theory of Elasticity," *Mc-Graw Hill Book Company, N.Y. , USA, 1970.*

Reference Books:

1. Love, A.E.H., "The Mathematical Theory of Elasticity," *Dover Publications, NewYork, USA, 1944.*

RENEWABLE ENERGY SYSTEMS

COURSE OUTCOMES:

1. To compare aware about different renewable energy resources.
2. To know the conversion of energy from one form to other.
3. To know the importance the solar radiation and its utilization.
4. To analyze of different energy conversion energy systems.

COURSE CONTENT:-

UNIT-I

Introduction

Introduction to energy, Relevance of energy in the development of country, conventional, non-conventional and renewable sources of energy. Status of conventional sources of energy and their conservation, Exploring renewable sources of energy.

UNIT-II

Solar Radiation and Applications of Solar Heat

Extraterrestrial solar radiation, components of radiation, geometry of earth and sun, geometry of collector and the solar beam, effects of earth's atmosphere, measurements of solar radiation, type of water heaters, selective surfaces, space heating, space cooling, water desalination, solar ponds, solar concentrators, thermos- electric power system, problems.

Photovoltaic Generation

Introduction, the silicon p-n junction, photon absorption solar radiation input, photovoltaic circuit properties and loads, limits to cell efficiency, solar cell construction, other types of photoelectric and thermo-electric generation.

UNIT-III

Hydro and Wind Powers

Principle of hydro power conversion, impulse turbine, reaction turbines, wind turbine types, linear momentum and basic theory, dynamic matching, characteristics of the wind, power extraction by a turbine, electricity generation, mechanical power, problems.

Bio-Fuels

Introduction, Bio fuels, classification, bio-mass production for energy farming, direct combustion for heat, pyrolysis (destructive distillation), alcoholic fermentation, anaerobic digestion for bio-gas, agrochemical fuel extractions.

UNIT-IV

Wave Energy and Tidal Power

Introduction, wave motion, wave energy and power, wave patterns, devices, the causes of tides, enhancement of tides flow power, tidal range, power, world tidal power sites.

OTEC and Geothermal Energy

Principles of Ocean Thermal Energy Conversion (OTEC), Claude cycle, Anderson cycle, Introduction to geothermal energy, dry rock and hot aquifer analysis, harnessing geothermal resources

Text Books:

1. Solar Energy by S P Sukhatme, Publisher Tata Mc Graw- Hill New Delhi

Reference Books:

1. Renewable Energy Resources by John W. Twidell and Anthony D. Weir, published by E. & F. N. Spon Ltd, London.
2. Renewable Energy by Bent Sorensen by Academic Press
4. Non-conventional Energy Sources by G D Rai by Khanna Publishers Delhi

ADVANCED WELDING AND ALLIED PROCESSES

Course Outcomes:

- CO1 Identify the use of welding processes in manufacturing industries.
- CO2 Apply knowledge to select appropriate welding process based on the application.
- CO3 Explain welding of plastics and underwater welding.
- CO4 Understand the process of thermal spraying and thermal cutting.

UNIT I

Introduction to welding

Welding Principle, Application of welding in industries, Weld ability of Material, Arc welding consumables, Shielding gases and association mixtures. Weld bead geometry and shape factors. Weld dilution, weld joint configurations, liquation cracking, hot cracking. Automation in welding.

UNIT II

Fusion and Solid state welding

Fusion Welding Processes: Classification of fusion welding processes, Submerged Arc Welding, Electroslag welding, Plasma arc welding.

Solid state welding: Introduction, Advantages of solid state welding over fusion welding processes, Explosive welding, Ultrasonic welding, Friction welding, Friction stir welding, Welding zones in FSW.

UNIT III

Welding of Plastics and Underwater welding

Plastics, Types of plastics, Welding of Plastic: Introduction, Classification of plastic welding, Hot plate welding, Hot gas welding, Ultrasonic welding, Friction welding, Applications of plastic welding.

Underwater Welding: Need and application of underwater welding, Dry underwater welding, wet underwater welding. Advantages and Limitations of dry and wet underwater welding.

UNIT IV

Thermal Spraying and Thermal Cutting

Thermal spraying: Introduction, Thermal spray processes, Application of thermal spraying, Thermal Cutting of Metals: Introduction, Methods and applications. Oxy-Fuel Gas Cutting, cutting torch, Oxygen-Lance Cutting, Plasma Arc cutting.

Text books:

- Manufacturing Science-A. Ghosh and A.K. Malik, Affiliated East Press, New-Delhi.
- Introduction to Manufacturing Processes- John A. Schey, McGraw-Hill, New-York

Reference books:

- Rao, P.N., Manufacturing Technology, Volume 2, McGraw-Hill Education, New Delhi.
 - Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston
 - Khan N. Z, Siddiquee A. N. and Khan Z. A., Friction stir welding of dissimilar Aluminium alloys, CRC Press, Boca Raton, 2017.
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Course No.: MET 458

**MECHANICS OF COMPOSITE
MATERIALS**

C L T (4 3 1)

MECHANICS OF COMPOSITE MATERIALS

COURSE OUTCOMES

On completion of this subject students will be able to:

1. To identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
2. To predict the failure strength of a laminated composite plate
3. Understand the linear elasticity with emphasis on the difference between isotropic and anisotropic material behaviour.
4. Acquire the knowledge for the analysis, design, optimization and test simulation of advanced composite structures and Components.

UNIT -1

Definition and classification of composite materials: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon Composites. Reinforcements and Matrix Materials. Manufacturing Techniques of Composites: Fiber Reinforced Plastic (FRP) Processing: Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding. Fabrication Process for Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

UNIT -2

Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approach, Halpin-Tsai Equations, Transverse Stresses. Thermal Properties; Expression for Thermal Expansion Coefficients of Composites, Expression for Thermal Conductivity of Composites, Hygral and Thermal Stresses. Mechanics of Load Transfer from Matrix to Fiber; Fiber elastic-Matrix Elastic, Fiber Elastic-Matrix Plastic. Load transfer in Particulate Composites. Numerical Problems.

UNIT -3

Elastic Constants of an Isotropic Material, Elastic Constants of a Lamina, Relationship between Engineering Constants and Reduced Stiffnesses and Compliances, Variation of Lamina Properties with Orientation, Analysis of Laminated Composites, Stresses and Strains in Laminate Composites, Inter-laminar Stresses and Edge Effects. Numerical Problems.

UNIT -4

Tensile and Compressive strength of Unidirectional Fiber Composites. Fracture Modes in Composites; Single and Multiple Fracture, Debonding, Fiber Pullout and Delamination Fracture. Strength of an Orthotropic Lamina; Maximum Stress Theory, Maximum Strain Criterion, Tsai-Hill Criterion, Quadratic Interaction Criterion, Comparison of Failure Theories. Fatigue; S-N Curves, Fatigue Crack Propagation Tests, Damage Mechanics of Fatigue, Thermal Fatigue. Creep behavior of Composites.

UNIT -5

Symmetric Laminates, Cross-ply laminates, Angle ply Laminates, Antisymmetric Laminates, Balanced Laminate. Failure Criterion for a Laminate. Design of a Laminated Composite. Numerical Problems.

TEXT BOOKS:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005
2. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012
3. Robert M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1999.

REFERENCE BOOKS:

1. Madhijit Mukhopadhyay, Mechanics of Composite Materials & Structures, Universities Press, 2004
2. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, McGraw Hill International, 2009
3. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993
4. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

Elective VI: Thermal

Course No.: MET 459

Advanced Fluid Mechanics

C L T (4 3 1)

After the completion of course, students will be able,

CO1	To have a good knowledge of the methods and techniques in viscous flows theory and be in a position to interpret viscous flow phenomena
CO2	To write Navier-Stokes equations (conservation laws for mass, momentum, and energy) for simple fluids
CO3	To solve for velocity and pressure fields in a viscous flow subjected to steady and transient conditions and formulate boundary layer approximations
CO4	To identify, formulate and solve flow problems by applying knowledge of fluid mechanics and mathematics

UNIT I

Introduction, Concept of a fluid, Concept of Viscosity, Concept of Continuum, Properties of a fluid, Historical outline, Flow analysis Techniques, Eulerian and Lagrangian flow description, Classification of fluid flows, Velocity and acceleration field, Material derivative, Control Volume and differential element approach, Reynolds Transport Theorem, Conservation of mass, Linear Momentum Equation, Energy Equation, Fluid Element kinematics, Linear motion and deformation, Angular motion and deformation.

UNIT II

Vectors and Tensors, Representation of second order tensor, Addition, subtraction and multiplication of tensors, Transpose of a tensor, Symmetric and Unsymmetric tensor, Unit tensor, Dyadic product, Divergence, Curl, Gradient of a vector and tensor, Significance of Gradient of velocity vector, Deformation, rotation, Divergence Theorem, Constitutive Equations for fluids, Stress Tensor for a simple flow, Stoke's Principle, Navier-Stokes Equation.

UNIT III

Exact Solutions of the Navier-Stokes Equations, Flow between through a straight stationary channel, Couette Flow, Hagen-Poiseuille flow, Flow between two concentric rotating cylinders, Axially moving concentric cylinders, Unsteady parallel flow (Stoke's first problem), Flow near an oscillating flat plate (Stoke's second problem), start-up of Couette flow, Transient axisymmetric Poiseuille flow, Flow of two immiscible fluids in a channel, Fully developed flow of a power law fluid, Superposition of Poiseuille and Couette flows.

UNIT IV

Laminar Boundary layers, Boundary-layer equations, Flow over a Flat plate, Blasius flow, Momentum-Integral Equation for the Boundary layer, Approximate methods for Boundary layer equations, Karman-Pohlhausen Method for Flow over a Flat Plate, Turbulent boundary layers, Characteristics of Turbulent flow, Laminar-Turbulent Transition, Engineering implications of turbulence, Correlation functions, Reynolds decomposition, Governing Equations for Turbulent flow, Measurement of Turbulence quantities, Shear-stress models, Prandtl's Mixing Length Hypothesis.

Textbooks:

1. White, F.M., "Viscous Fluid Flow", McGraw Hill, 2013.
2. Schlichting, H., "Boundary Layer Theory", McGraw Hill, 1979.

Reference Books:

1. Muralidhar, K., Biswas, B., "Advanced Engineering Fluid Mechanics", Narosa Publishing House, 2015.
2. Graebel, W.P., "Advanced Fluid Mechanics", Academic Press, 2009.
3. Aris, R., "Vectors, Tensors and Basic Equations of Fluid Mechanics", Dover Publications, 1962.
4. Munson, B.R., Young, D.F., Okiishi, T.H., Fundamentals of Fluid Mechanics, Wiley, 2017.

Elective VI: Production

Course No.: MET 460

Value Engineering
VALUE ENGINEERING

C L T (4 3 1)

UNIT I:

Introduction to value engineering (VE) & value analysis (VA), Life Cycle of a product, Methodology of VE, Reasons for the existence of unnecessary costs. Quantitative definition of Value, use Value and Prestige value, Estimation of product Quality/Performance, Types of functions, Relationship between use functions and Esteem Functions in product design, Functional cost and functional worth, Effect of value improvement on profitability, Tests for poor value, Aims of VE systematic approach.

UNIT II

Elementary introduction to VE, Job plan functional approach to value improvement, Various phases and techniques of the job plan, Factors governing project selection, Types of projects, Life cycle costing for managing the total value, concepts in LCC, Present value concept, Annuity concept, net present value, Pay Back period, internal rate of return on investment (IRR), Examples and Illustrations. Creative thinking and creative judgement, positive or constructive discontent, Tangible and intangible costs of implementation, False material, Labour and overhead saving, VE/VA yardsticks, Relationship between savings and probability of success, Reliability Estimation, system Reliability, Reliability elements in series and parallel.

UNIT III

PHASES AND TECHNIQUES OF VE JOB PLAN:

General Phase, Information phase, Function phase, Creativity/Speculation Phase, Evaluation Phase, Investigation Phase and Recommendation Phase: Value improvement recommendation theory, determination of cut-off point (cop), road blocks in implementation. Decision Matrix/Evaluation Matrix, Quantitative comparison of Alternatives, Estimation of weights factors and efficiencies, Utility transformation functions, Bench marking, Perturbation of weight factors (sensitivity analysis), and Examples.

FAST Diagramming: Critical path of functions, HOW, WHY & WHEN Logic, Supporting and all time functions.

Reference Books:

2. Arthur E. Mudge, "Value Engineering- A Systematic Approach", *McGraw Hill Book Co.* 1971.
3. Miles L.D., "Techniques of value Analysis and Engineering", *McGraw Hill Book Co., New York, 1970.*
4. ASTME-American society for Tool and Manufacturing Engineers," Value engineering in Manufacturing", *Prentice Hall Inc. USA, 1967.*

Course No.: MEP463

MAJOR PROJECT – Stage II

C L T (9 0 0)

- CO1** Identify methods and materials to carry out experiments/develop code.
- CO2** Reorganize the procedures with a concern for society, environment and ethics.
- CO3** Analyze and discuss the results to draw valid conclusions.
- CO4** Prepare a report as per recommended format and defend the work.
- CO5** Explore the possibility of publishing papers in peer-reviewed journals/conference proceedings.